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A SUMMARY OF THE NAVAL POSTGRADUATE SCHOOL RESEARCH PROGRAM AND RECENT PUBLICATIONS

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NAVAL POSTGRADUATE SCHOOL
Monterey, CA 93943

Rear Admiral R.W. West, jr.
Superintendent

H. Shull
Provost

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This report contains 330 summaries of research projects which were carried out under funding of the Naval Postgraduate School Research Program. A list of recent publications are also included which consist of conference presentations, contributions to books, published papers, and technical reports. The research was conducted under the areas of Computer Science, Mathematics, Administrative Sciences, Operations Research, National Security Affairs, Physics, Electrical and Computer Engineering, Meteorology, Aeronautics and Astronautics, Oceanography, and Mechanical Engineering.

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INTRODUCTION

This volume summaries faculty research activity during fiscal year 1989, and it lists recent publications and conference presentations. A separate volume, "Naval Postgraduate School Compilation of Abstracts of Theses Submitted by Candidates for Degrees," is a compilation of abstracts of theses written at NPS during 1989.

Research is an integral part of the graduate eduction and there is a close connection between faculty research and student theses. Approximately 800 Masters Theses are written annually at the Naval Postgraduate School and many of the projects shown here make reference to those theses.

The projects summarized in this volume are organized by the academic department of the principal investigator. This provides a natural grouping by subject area, but does not give adequate recognition to the significant amount of research in the interdisciplinary areas, in particular the work of the school's Academic Groups in Antisubmarine Warfare, Space Systems, Electronic Warfare, and in Command, Control, and Communications.

The Naval Postgraduate School wishes to acknowledge Jodie Young for her efforts in the preparation of this volume.

Additional information about research activities at NPS can be obtained from the Director of Research Administration, Code 012, Naval Postgraduate School, Monterey, California, 93943.

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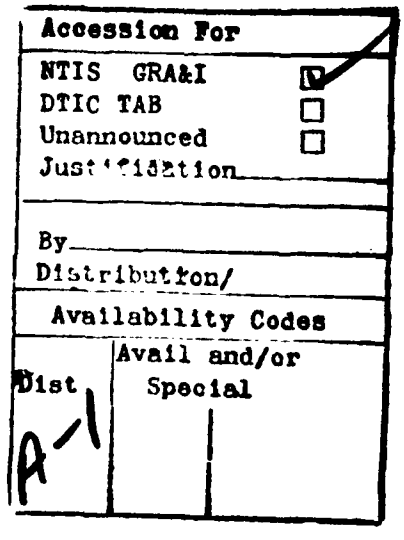

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DEPARTMENT OF AERONAUTICS AND ASTRONAUTICS

DEPARTMENT OF AERONAUTICS AND ASTRONAUTICS

This research which is being conducted by the faculty members of the Department of Aeronautics and Astronautics is directed toward the solution of current Naval aviation and other military civilian aviation problems. The following major projects are under investigation:

HIGH ANGLE OF ATTACK FIGHTER AIRCRAFT AERODYNAMICS

This project involves a collaborative effort among Professors Platzer, Chandrasekhara, Hebbar, Howard, and Ekaterrinaris to investigate the flow behavior around fighter aircraft configurations during high angle of attack maneuvers and to develop new concepts to enhance fighter aircraft maneuverability. The approach includes the development of Navier Stokes and viscous-inviscid interaction methods, water tunnel studies of the effect of pitch rate on the vortex break-up on F-18 fighter aircraft models, wind tunnel studies of the effect of compressibility on dynamic stall of airfoils, and wind tunnel studies of the effect of free stream turbulence on airfoil boundary layers.

HELICOPTER AERODYNAMICS AND VIBRATION CONTROL

Studies are in progress by Professors Wood, Kolar, Platzer, Chandrasekhara, Healey, and Miller to investigate various aerodynamic, gust response, and vibration control aspects applicable to helicopters. They include wind tunnel investigations of the effect of Mach number of the dynamic stall of oscillating airfoils, the effect of leading edge geometry on the lift of airfoils and circulation controlled cylinders in oscillating flow, analytical investigations of higher harmonic control of helicopter blade vibrations, and wind tunnel investigations of the effect of ship airwakes on helicopter flight operations.

UNMANNED AIR VEHICLES FLIGHT TEST RESEARCH PROGRAM

Professors Howard, Hauser, and Wood are engaged in a research program for the flight testing of unmanned air vehicles for joint service applications. This program involves aerodynamic performance, and stability and control flight research with radio-controlled unmanned air vehicles to support current and future UAV systems.

HIGH ANGLE OF ATTACK MISSILE AERODYNAMICS

Professor Howard is investigating aerodynamic phenomena related to Navy ship launched missiles. They include the effects of flowfield turbulence on the formation of nose generated asymmetric vortices and the induced side forces on a wing strake missile.

AIRCRAFT AND MISSILE PROPULSION RESEARCH

Professors Shreeve, Netzer, Platzer, Hobson, and Ekaterinaris are studying several aircraft and missile propulsion problems. They include a wind tunnel investigation of a new flow separation alleviation scheme for fan blades, experimental investigations of methods for the reduction of emissions from gas turbine combustors and test cells, computational investigations of unsteady viscous cascade flows and of unsteady heat transfer on turbine blades, and experimental investigations of the combustion behavior of solid fuel ramjets and solid rocket motor exhaust plume particulate and signature measurements.

CONTROL SYSTEMS STUDIES

Professors Collins and Schmidt are conducting studies directed toward both aircraft and ship control. They include the application of modern H norm controllers and sliding mode controller to advanced Navy fighter aircraft, the investigation of inertial coupling as a mechanism for high angle of attack aircraft wing rock, the development of a robust observer for ship rudder control, the modelling of the ship dynamics, and the development of ship motion forecasting methods.

COMPOSITE MATERIALS RESEARCH

Professors Wu and Gorman are studying various aspects of the failure processes of composite materials. They include the establishment of the necessary facilities and the characterization methodology for strength aging

studies of composite materials, the modelling of the physical failure processes of composite materials, the measurement of parameters for proof test of critical composite structures, the formulations of a failure criterion for combined stress conditions, the establishment of an experimental facility to obtain compressive life durability data, the development of new acoustic emission transducers to detect composite material failures, the new investigation of progressive cracking in graphite/epoxy using acoustical techniques, and the investigation of the wave modes produced by tearing adhesives in double cantilever beam specimens.

AIRCRAFT SURVIVABILITY STUDIES

Professor Ball is conducting applied research in several areas of combat survivability, including an assessment of aircraft survivability in the many-on-many scenario, the assessment of aircraft vulnerability in the conceptual design phase, aircraft survivability to the DEW threats, and live fire testing of aircraft.

NEURAL NETWORKS

Professor Collins is conducting research in the application of neural networks to target identification with ISAR images and radar signals. Further research is being conducted using neural networks in estimation and control theory.

NPS SURVIVABILITY SUPPORT

Robert E. Ball - Professor of Aeronautics and Astronautics
Sponsor: Combat Survivability Branch, Naval Air Systems Command

OBJECTIVE: To provide technical support to the Air Combat Survivability Branch by conducing research and developing methodology in several areas of aircraft combat survivability.

SUMMARY: The survivability areas worked on in 1989 included 1) aircraft vulnerability to directed energy weapons, 2) satellite survivability, 3) the contribution of external ordnance to aircraft vulnerability, 4) the susceptibility of low speed/low maneuvering aircraft to infrared homing missiles, 5) the survivability of reconnaissance aircraft, and 6) the employment of the ALE-39 chaff and flare dispenser system.

THESES DIRECTED: Victor C. See, Jr., "Aircraft Vulnerability to Directed Energy Weapons," M.S. September, 1989.

Gary A. Shaw, "An Introduction to Satellite Combat Survivability Analysis and Design," M.S., September, 1989.

Douglas A. Ray, "The Contribution of External Ordnance to Aircraft Vulnerability," M.S., December, 1989.

Hock Teck Chsa, "Reducing the Susceptibility of Low Speed/Low Maneuverable Aircraft to Infrared Missile Kills," M.S., December, 1989.

James D. Linger, Classified Thesis, M.S., June, 1989.

Thomas J. Meyers, Classified Thesis, M.S., September, 1989.

CONTROL SYSTEM DESIGN OF ADVANCED FIGHTER AIRCRAFT

Daniel J. Collins - Professor of Aeronautics and Astronautics
Sponsor: Naval Air System Command

OBJECTIVE: The Naval Air Systems Command is actively concerned with the development of advanced fighter concepts. Modern fighter aircraft involve multi-input multi-output (MIMO) control systems. Recent advances in stability robustness concepts and theory permit the development and MIMO controller that meet robustness and performance requirements for modern fighters. The X-29, which has a large negative static stability margin, was taken as a generic modern fighter. A modern norm controller using H2 and H methods will be designed. In successive years, nonlinear controllers and the application of adaptive neural networks to MIMO robust control system will be investigated.

SUMMARY: Two and three input-output controllers have been designed for the longitudinal analog backup mode for a 14 state model of the X-29 aircraft. These controllers were developed from the two Riccati solution for the H infinity problem. When the solution was not limited by actuator dynamics decoupled motion of the aircraft was strongly evident (i.e. direct pointing). Limiting the energy input to obtain realistic actuator performance results in degradation in the controller response.

THESES DIRECTED: W. Rogers, LCDR, USN, "Application of Modern Control Theory to a Super-Augmented Aircraft," M.S., June, 1989.

Ta-Chieh Hus, CPT, Taiwan Army, "Application of H Infinity Methods to Modern Fighter Configuration," M.S., December, 1989.

NEURAL NETWORK I
APPLICATION OF PARALLEL DISTRIBUTED PROCESSING SYSTEMS TO FAULT DETECTION AND ENGINE DIAGNOSTICS

Daniel J. Collins - Professor of Aeronautics and Astronautics

OBJECTIVE: Parallel Distributed Processing (PDP) in the form of neural networks will be used to analyze F-18 engine signals obtained from the engine monitoring system. The neurual network will be trained to recognize both normal operation and failure modes. Particular emphasis will be placed on determining if the neural network can pre-predict catastrophic compressor failure. Other aspects of military applications of neural networks will also be considered.

SUMMARY: A neural network was developed that successfully recognized normal operation and failure modes in the F-18 engine. The available data was limited to only 5 seconds before compressor failure and the network was able to pre-predict the coming failure. The record time is so short that the prediction is not practically useful. This suggests that the recording time should be increased to 30 seconds to a minute. If in this case the neural network could predict correctly, the coming failure, the pilot would have a chance to take corrective action.

In other applications of neural networks, very interesting results were obtained in identifying radar images.

THESES DIRECTED: J.T. Gengo, LCDR, USN, "Application of Neural Networks to the F/A-18 Engine Condition Monitoring System," M.S., September, 1989.

T.M. McKannon, LCDR, USN, "Application of Artificial Neural Networks to Inverse Synthetic Aperture Radar Image Classification," Engineer's Degree, June, 1989.

NEURAL NETWORKS II
ALTERNATE CONTROLLERS FOR THE F-18 HIGH ANGLE OF ATTACK

D.J. Collins - Professor Aeronautics and Astronautics
Sponsor: Naval Air Systems Command

OBJECTIVE: The Naval Air Systems Command will be conducting high angle of attack investigations of the F-18. Alternate controllers will be developed for the aircraft based on H infinity methods. In a recent research effort involving the X-29, a decoupling controller resulted from an H infinity analysis. It is possible to have a directed implementation of modern control concepts such as direct pointing control. Some work will also be done on adaptive controllers based on neural networks.

SUMMARY: High angle of attack data (to 35°) has been requested on the F-18. Work has not yet started on the H infinity controllers, but some fundamental investigations have been completed using neural networks as adaptive controllers. This work will need to be further extended before it can be applied to the F-18 aircraft.

THESES DIRECTED: R.W. Scott, LT, USN, "Application of Neural Networks to Adaptive Control," Engineer's Degree, December, 1989.

HIGH ALPHA HIGH SPEED AERODYNAMICS RESEARCH

M.S. Chandrasekhara, Adjunct Research Professor of Aeronautics and Astronautics
M.F. Platzer, Professor of Aeronautics and Astronautics
Sponsor: Naval Air Systems Command

OBJECTIVE: To study the unsteady aerodynamic effects on an airfoil undergoing rapid maneuver such as a rapid pitch-up like that encountered in aircraft with supermaneuverability an ability capabilities.

SUMMARY: This project complements the research going carried out under funding from AFOSR. For the reporting period, some additional instrumentation components were acquired to conduct Laser Doppler Velocimetry studies. The software package that was developed in the previous reporting period for acquisition of Laser Doppler Velocimetry data in unsteady flows was modified to incorporate extensive graphics capabilities.

CONFERENCE PRESENTATIONS: M.S. Chandrasekhara and L.W. Carr, "Design and Development of a Facility for Compressible Dynamic Studies of a Rapidly Pitching Airfoil," the 13th International Conference on Instrumentation of Aerospace Simulation Facilities, Goettigen, West Germany, September 18-21, 1989.

COMPRESSIBILITY EFFECTS ON THE DYNAMIC STALL OF AIRFOILS UNDERGOING RAPID RAMP TYPE MOTION

M.F. Chandrasekhara, Adjunct Research Professor, Aeronautics and Astronautics
M.F. Platzer, Professor, Aeronautics and Astronautics
Sponsor: U.S. Air Force Office of Scientific Research

OBJECTIVE: To study the effect of compressibility on the dynamic stall of an airfoil undergoing a rapid ramp type pitching motion with applications to supermanuverability of fighter aircraft. This on-going project began in October 1986 and was renewed in September 1989.

SUMMARY: The major accomplishment during the reporting period was the fabrication and installation of a hydraulic drive with a feedback control system to rapidly pitch an airfoil at rates as high as 3600 degrees/sec. This in effect simulates a pitch-up maneuver of an airplane wing from 0 to 60 degrees at 90 degrees/sec. Detailed system checkout and calibration for satisfactory performance were carried out. Preliminary testing to obtain flow visualization pictures was initiated. Necessary modifications to the circuitry built for the ARO project were made to trigger the light source at the high rates encountered in this application for this purpose. Also, high speed imaging optics requirements were identified. Detailed testing began in October 1989 as a continuation project.

CONFERENCE PRESENTATION: M.S. Chandrasekhara and L.W. Carr, "Design an development of a Facility for Compressible Dynamic Studies of a Rapidly Pitching Airfoil," the 13th International Conference on Instrumentation of Aerospace Simulation Facilities. Goettigen, W. Germany, September 18-21, 1989.

COMPRESSIBILITY EFFECTS ON THE DYNAMIC STALL OF OSCILLATING AIRFOILS

M.S. Chandrasekhara, Adjunct Research Professor, Aeronautics and Astronautics
M.F. Platzer, Professor, Aeronautics and Astronautics
Sponsor: U.S. Army Research Office

OBJECTIVE: To study the effects of compressibility on the dynamic stall of oscillating airfoils with applications to helicopters. This information will be useful in extending the flight envelope of future helicopter systems. This ongoing program began in March 1986.

SUMMARY: The flow over a helicopter "retreating" blade is being simulated in the newly built compressible dynamic stall facility (CDSF) and studied with a view to understand the basic flow physics for possible improvements in the blade design. During the reporting period, the compressibility effects on an oscillating airfoil was studies, in particular when the amplitude of oscillation was varied. The results show that the amplitude parameter has strong effects on the dynamic stall process. Also, for the first time, a shock was observed on the airfoil, which till now has only been postulated to be present. In addition, modifications were made to the CDSF to improves it capabilities.

CONFERENCE PRESENTATIONS: M.S. Chandrasekhara and L.W. Carr, "Flow Visualization Studies of the Mach Number Effects on the Dynamic Stall of Oscillating Airfoils," AIAA Paper No. 89-0023, AIAA 27th Aerospace Sciences Meeting, Reno Nevada, Jan. 9-12, 1989.

L.W. Carr and M.S. Chandrasekahara, "Design and Development of a Compressible Dynamics Stall Facility," AIAA PAPER 89--0647, AIAA 27th Aerospace Sciences Meeting, Reno, Nevada, Jan. 9-12, 1989.

L.W. Carr, M.F Platzer, M.S. Chandrasekhara, and J.A. Ekaterinaris, "Experimental and Computational Studies of Dynamic Stall," 4th Symposium on Numerical and Physical Aspects of Aerodynamic Flows, Long Beach, CA., Jan. 16-18, 1989.

THESIS DIRECTED: B.E. Brydges, CPT, USA, "Flow Visualization of Dynamic Stall on an Oscillating Airfoil," M.S., September 1989.

DYNAMIC INTERFACE – AIRWAKE TAILORING

J.V. Healey, Associate Professor of Aeronautics and Astronautics
Sponsor: Naval Air Systems Command

OBJECTIVE: Flow visualization analyses at NPS over the past few years indicate that many existing problems involving helo blade strikes and narrow safe-operating envelopes are due to lack of aerodynamic design of ship superstructures. This project has the combined aim of attempting to tailor very unfavorable flows on existing ships and investigating the elements of good design for future ships.

SUMMARY: This project is in the early stages. Three thesis students are involved; one in numerical modeling, using a Navier Stokes code, another on the physical modeling, and a third on investigation of the origin of separated shear layers that cause blade strikes on AOR ships.

CONFERENCE PRESENTATIONS: J.V. Healey, "Ship Airwakes" American Society of Naval Engineers, ASNE Day Conference, Washington, DC., May 1989.

J.V. Healey, "Interface Research at NPS," Aerodynamic Ship Interface Conference, Washington, DC., November 1989.

DYNAMIC INTERFACE - SHIP AIRWAKE ANALYSIS

J.V. Healey, Associate Professor of Aeronautics and Astronautics
Sponsor: Naval Air Systems Command

OBJECTIVE: Map the airwake of 1/140 scale model 9 of the DD-963 along specified helicopter flight paths.

SUMMARY: A simulated neutrally stratified atmospheric boundary layer has been set up in the "Smoke" tunnel at NPS. In order to establish a Database for a simulation of the helicopter/ship interface, data from the airwake of a suitable model in this layer is required. A single triple hot-wire anemometer, in conjunction with a computer controlled traverse, has been used to acquire the data. These were digitized and processed to obtain the mean velocity, the next three moments of the distribution, the auto-correlations,and the spectrum functions. Integral length scales were estimated from the auto-correlations. All are available for 15 positions in the wake along each of three flight paths. These data are in a form suitable for testing in the NSAA simulator. Velocities in the wake are always less than in the freestream; along wind turbulence intensities up to about 40% have been found. The presence of the ship drastically reduces the longitudinal length scales, but they gradually recover as the wake recedes from the ship. Spectra at all points in the free-stream flow and in the wake exhibit the typical Kolmogoroff -5/3 law roll-off at high frequency and peak at frequencies between 2 and 10 Hz. There is considerable less low-frequency energy in the wake than in the freestream flow.

PUBLICATIONS: J.V. Healey, "Establishing an Airwake Database for Flight in the Wakes of Structures," in progress.

THESIS DIRECTED: Gustav Anderson, LT, USN, "Mapping the Airwake of a DD-963," M.S., December, 1989.

DYNAMIC INTERFACE - ROTOCRAFT STUDIES

J.V. Healey, Associate Professor of Aeronautics and Astronautics
Sponsor: Naval Air Systems Command

OBJECTIVE: There is little current research into turbulence modeling of helos and none that involves flight in the wakes of structures. Because of the imminent availability of the airwake data, and the existence of no satisfactory helo model, entry into this field was necessary. This is likely to be a continuing project with the aim of understanding helo rotor blade responses in non-uniform turbulent flows, ground effects and the simulation of helo motion in the ship airwake.

SUMMARY: During the spring of 89, several equipment failures meant a temporary abandonment of the airwake measurements and commencement of the present analytic project. This was begun with review of various models for rotor blades, ground effects and simulation. Some time was spent on an interesting model of rotor down and up wash. This involved the motion of vortex rings that are generated impulsively in a plane and travel, either through a semi-infinite fluid or interact with the ground. This work is continuing. A thesis student is currently continuing the work on blade motion and helo simulations models.

PUBLICATIONS: J.V. Healey, "Some Numerical Experiments with Generation and Subsequent Motion of Vortex Rings," in progress.

HIGH-ALPHA LOW-SPEED AIRCRAFT AERODYNAMICS RESEARCH

S.K. Hebbar, Adjunct Professor, Aeronautics and Astronautics
M.F. Platzer, Professor, Aeronautics and Astronautics
Sponsor: Naval Air Systems Command

OBJECTIVE: This is a multi-year program aimed at establishing a state-of-the-art research center for high-angle of attack, low speed steady/unsteady aerodynamic studies at the Naval Postgraduate School.

SUMMARY: A low speed experimental program on high-alpha steady/unsteady aerodynamics was pursued in the low speed wind tunnel and the water tunnel of the Naval Postgraduate School, to carry out the investigations related to enhance fighter maneuverability. During the period under review, the following major tasks were accomplished: a) A systematic program of dynamic flow visualization studies of pitch-rate effects on a 2% F/A-18 fighter aircraft model was initiated in the water tunnel with dye injection to visualize vortex formation and bursting. b) Investigation of the strut interference effects on a 3% YF-17 aircraft model at high angles of attack in the NPS low speed wind tunnel, using laser sheet visualization and force balance measurements. This investigation carried out at the request of NASA Ames Research Center has provided full scale F-18 tests in the NASA-Ames 80 ft x 120 ft wind tunnel. c) Design and fabrication of a water tunnel model of a canard - wing configured Navy X-31 aircraft (fabrication in progress at NASA-Ames Research Center). d) Initiation of water tunnel studies to explore the potential of "trapped dynamic stall vortex" concept for enhanced fighter maneuverability.

PUBLICATIONS: S.K. Hebbar and M.S. Chandrasekhara, and J.S. Chlebanawshi, "Flow Visualization by Laser Sheet," Proceedings of the 4th Asian Congress of Fluid Mechanics, Vol. 1, pp. G49-G52, Hong Kong, August 1989.

CONFERENCE PRESENTATIONS: S.K. Hebbar, M.S. Chandrasekhara, and J.S. Clebanowski, "Flow Visualization by Laser Sheet," 4th Asian Congress of Fluid Mechanics, Hong Kong, August 21-25, 1989.

THESES DIRECTED: S.N. Park, MAJ, Korean Air Force, "Flow Visualization of the Effect of Pitch Rate on the Vortex Development on the Scale Model of a F-18 Fighter Aircraft, M.S., June 1989.

J.D. Sommers, LT., USN, "An Experimental Investigation of the Support Strut Interference on a 3% YF-17 fighter Aircraft Model at High Angles of Attack," M.S., September 1989.

A FLIGHT TEST RESEARCH PROGRAM FOR JOINT-SERVICE UNMANNED AIR VEHICLES

R.M. Howard, Assistant Professor of Aeronautics and Astronautics
J.P. Hauser, Associate Professor of Aeronautics and Astronautics
Sponsor: Naval Air Systems Command

OBJECTIVE: To develop a research program for small Unmanned Air Vehicles (UAVs), and to conduct research in the areas of performance and flying qualities of advanced UAVs.

SUMMARY: A research program is ongoing for the flight testing of Unmanned Air Vehicles (UAVs) for joint service applications. Current work is addressing some problems identified for a UAV being flown off of two battleships, the USS IOWA and the USS NEW JERSEY. Over the reporting period data have been gathered to correlate with predicted drag from a computer analysis. Most of the year has been spent in development of instrumentation and appropriate flight test methods that best apply to small radio controlled aircraft. Whereas the past work has supported the PMA, the work for the coming year will support developing technologies for the PDA within the Unmanned Aerial Vehicle Joint Project Office. This program also contributes to the Flight Test Engineering course.

PUBLICATION: R.M. Howard, J.C. Tanner, D.F. Lyons, and D.E. Meeks, "Flight Test and Numerical Analysis of a Half-Scale Unmanned Air Vehicle," AIAA Paper 90-1260, forthcoming.

THESES DIRECTED: J.C. Tanner, LT., USN, "Development of a Flight Test Methodology for a U.S. Navy Half-Scale Unmanned Air Vehicle," M.S., March, 1989.

N.D. Bamichas, CPT, Hellenic Air Force, "Flight Test Method Development for a Quarter-Scale Aircraft with Minimum Instrumentation," M.S., March 1989.

D.R. Lyons, CPT, USM, "Aerodynamic Analysis of a U.S. Navy and Marine Corps Unmanned Air Vehicle," M.S., June 1989.

Y. Kee, MAJ, Korean Air Force, "Initial Flight Test of a Half-Scale Unmanned Air Vehicle," M.S. Thesis, September, 1989.

EFFECTS OF THE LAUNCH ENVIRONMENT ON A VERTICALLY LAUNCHED MISSILE

R.M. Howard, Assistant Professor, Aeronautics and Astronautics
Sponsor: Naval Surface Warfare Center

OBJECTIVE: To experimentally study the effect of flowfield turbulence on the formation and existence of asymmetric vortices, which can induce significant unwanted side forces on the sharp noses of missiles and aircraft.

SUMMARY: A vertical launch capability for Navy surface to air missiles was recently introduced. Launching a missile vertically can expose it to significant crosswinds and flowfield disturbances from ship airwake turbulence. A wind-tunnel study of a 1/7-scale Navy surface-to-air missile has been conducted at high angles of attack at various levels of generated flowfield turbulence. During the reporting period, planar mappings in the lee flowfield were made with a 5-hole pressure probe for contours of crossflow velocities, pressure losses, and vorticity. The data were correlated with previous measurements of forces and moments to describe the significant effect of the flowfield turbulence on the formation of nose-generated asymmetric vortices and the resultant side forces.

PUBLICATION: R.M. Howard, M.P. Rabang, and D.P. Roane, Jr., "Aerodynamic Effects of a Turbulent Flowfield on a Vertically Launched Missile," Journal of Spacecraft and Rockets, Vol. 26, No. 6 Nov./Dec. 1989. pp. 445-451.

CONFERENCE PRESENTATION: R.M. Howard, M.P. Rabang, and D.P. Roane, Jr., "Aerodynamic Effects of a Turbulent Flowfield on a Vertically Launched Missile," AIAA 27th Aerospace Sciences Meeting, Reno, NV, January 9-12, 1989.

THESES DIRECTED: J.J. Viniotis, LT., USN, "Flowfield Effects of Launch on a Vertically Launched Missile," M.S., June 1989.

D.A. Johnson, CPT, USA, "Flowfield Measurements in the Wake of a Missile at High Angle of Attack," M.S., September 1989.

J.A. Pinaire, Jr., LT, USN, "Effects on Flowfield Turbulence on Asymmetric Vortices over a Slender Body," M.S., December 1989.

A.S. Dunn, LT, USN, "Aeropredictive Methods for Missile Analysis," M.S. Thesis, December, 1989.

UNSTEADY BOUNDARY LAYER EFFECTS ON SUPERMANEUVERABILITY

R.M. Howard, Assistant Professor, Aeronautics and Astronautics
Sponsor: NAVAIR, Aircraft Division, Research and Technology

OBJECTIVE: To study the wing boundary layer response to a high-frequency single-event turbulent disturbance at condition near separation. This work applies to a supermaneuverable aircraft in or near the post-stall flight regime.

SUMMARY: In many situations the boundary layer on a lifting surface can be sensitive to time-dependent disturbances in the flow environment. One important case relates to dynamic maneuvering for increased fighter agility. The immersion of a lifting surface in the separated turbulent wake of a second surface or body may lead to loss of control should the flow over that surface be adversely affected. Results at a post-stall angle of attack using a spinning rod upstream of the wing indicate that a stabilizing mechanism takes place to reattach the flow for certain reduced frequencies. Harnessing this mechanism for high angle-of-attack control remains to be considered.

PUBLICATIONS: R.W. Renoud and R.M. Howard, "Airfoil Boundary Layer Response to an Unsteady Turbulent Flowfield," AIAA Journal, Forthcoming.

R.M. Howard and S.J. Miley, "Time Dependent Boundary Layer Response in a Propeller Slipstream," Journal of Aircraft, Vol. 26, No. 9, September 1989, pp. 863-869.

R.M. Howard and D.W. Kindelspire, "Freestream Turbulence Effects on Airfoil Boundary Layer Behavior at Low Reynolds Numbers," Journal of Aircraft, forthcoming.

CONFERENCE PRESENTATION: R.M. Howard and R.W. Renoud, "Wing Boundary Layer Response to an Unsteady Turbulent Flowfield," AIAA 7th Applied Aerodynamics Conference, Seattle, WA, July 31-August 2, 1989.

THESIS DIRECTED: D.J. Gwilliam, LT., USN, "Effects of an Unsteady Turbulent Flowfield on Airfoil Separation at High Angles of Attack," M.S., December 1989.

PARTICULATE BEHAVIOR IN EXHAUST NOSSLES AND PLUMES OF SOLID PROPELLANT ROCKET MOTORS

D.W. Netzer, Professor, Aeronautics and Astronautics
Sponsor: Air Force Astronautics Laboratory

OBJECTIVE: Measurements of scattered and transmitted light, pulsed holography, and particle collection probes will be used to determine the effects of propellant composition and nozzle geometry on the particulate breakup and agglomeration processes within the exhaust nozzle and plume of a small, two-dimensional windowed rocket motor.

SUMMARY: Aluminum/aluminum oxide particle size distributions were measured in the combustion chamber, exhaust nozzle and exhaust plume. Increased pressure reduced particle agglomeration and increased C* efficiency. Exhaust particle D32 was 1.2-1.6 microns, independent of pressure, nozzle inlet contour, exit Mach number, degree of underexpansion and location aft of the exit plane. A new combined particle collection, optical sizing problem was successfully utilized in an initial investigation utilizing a propellant with 16% aluminum.

PUBLICATIONS: E.D. Youngborg, T.E. Pruitt, J.M. Smith, and D.W Netzer, "Light Diffraction Particle Size Measurements in Small Solid Propellant Rocket Motors," Journal of Propulsion and Power, vol. 6, no. 3, pp. 243-249, May-June, 1990.

W.D. Brennan, D.L. Hovland and D.W. Netzer, "Measured Aluminum/Aluminum Oxide Particulate Behavior in a Subscale Solid Propellant Rocket Motor," Journal of Propulsion and Power, Submitted.

E.D. Youngborg, T.E. Pruitt, D. Carrier, M.E. Smith, J.P. Powers, and D.W. Netzer, "Particle Sizing in Solid Propellant Rocket Motors," Proceedings of the 25th JANNAF Combustion Meeting, Chemical Propulsion Information Agency Publication 4988, Vol 1, pp. 155-174, 1989.

CONFERENCE PRESENTATIONS: D.W. Netzer, "Measurements of Exhaust Particulates," Invited Paper, Meeting of Mutual Weapons Development Data Exchange Agreement, WG III, Naval Weapons Center, China Lake, CA., July 18-19, 1989.

W.D. Hovland, D.L. Brennan, and D.W. Netzer, "Measured Aluminum/Aluminum Oxide Particulate Behavior in a Subscale Solid Propellant Rocket Motor, 18th JANNAF Exhaust Plume Tech. Subcommittee Meeting, NPS, Monterey, CA. November 14-17, 1989.

THESES DIRECTED: D.L. Hovland, "Particle Sizing in Solid Rocket Motors," Engineers Thesis, March 1989.

PARTICULATE BEHAVIOR IN EXHAUST NOSSLES AND PLUMES OF SOLID PROPELLANT ROCKET MOTORS (Cont)

K.J. Arnold, An Experimental Investigation of Strand Burning Metallized Solid Propellants," M.S., December 1989.

T.J. Eno, "A Combined Optical & Collection Probe for Solid Propellant Exhaust Particle Analysis," M.S., December 1989.

NOx EMISSION CONTROL FOR JET ENGINE TEST CELLS

D.W. Netzer, Professor, Aeronautics and Astronautics
Sponsor: Naval Air Propulsion Center

OBJECTIVE: To develop a new test cell, combustor test rig and instrumented augmenter tube for evaluation of various techniques which can be used to reduce NOx emissions from test cells. To initiate an investigation of the effects of inlet air temperature, fuel-air ratio and fuel additives on the effectiveness of two NOx reduction techniques. To implement a Mie scattering code on the Microvax for improving the soot particle size measurement technique.

OBJECTIVE: The improved Mie code was installed on the Microvax. The year was devoted to a complete redesign and installation of the gas turbine combustor and augmenter tube test apparatus in a new test cell. Delays in the receipt of the new gas sampling equipment and the catalytic unit prevented any testing to be conducted. NOx, unburned hydrocarbon and CO analyzers were purchased and installed together with heated sampling lines. A large augmenter tube was installed which is capable of providing variable augmentation ratio.

PUBLICATIONS: D. Netzer, "Soot Formation/ Additive Effective," NAPC Paper, 1989.

D. Netzer, "NOx Control for Gas Turbine Engine Test Cells," NAPC Paper, 1989.

D. Netzer and D. Salinas, "Modeling of Gas Turbine Engine Test Cells," NAPC Paper, 1989.

COMBUSTION BEHAVIOR OF SOLID FUEL RAMJETS

D.W. Netzer, Professor, Aeronautics and Astronautics
B. Natan, NRC Research Associate
Sponsor: Naval Weapons Center

OBJECTIVE: To evaluate metallized fuel composition effects on burning surface behavior and particle size. To evaluate the feasibility of using solid fuels for dual-mode and supersonic combustion ramjets.

SUMMARY: The solid fuel ramjet was successfully operated in both the dual-mode and full supersonic combustion configurations and confirmed conclusions from the earlier analytical studies. An investigation was initiated to determine the effects of solid fuel temperature cycling on the combustion characteristics and obtainable performance. Particle size measurements were obtained using a boron-based fuel. Particle size distributions aft of the grain were quadramodal, with mode peaks at 2,4,15 and 25-45 microns. At the nozzle entrance the distributions were trimodal due to the complete oxidation of the 2 micron particles. D32 and the size of the largest agglomerates increased with increasing equivalence ratio, indicating that long grains result in more surface agglomeration.

PUBLICATIONS: A. Karadimitirc, C. Scoot II, D. Netzer, and A. Gany, "Regression and Combustion Characteristics of Born Containing Fuel for Solid Fuel Ramjets," Journal of Propulsion and Power.

C. Vaught, M. Witt, D. Netzer, and A. Gany, "An Investigation of Solid Fuel, Dual-Model Combustion Ramjets," Journal of Propulsion and Power, Submitted.

CONFERENCE PRESENTATIONS: A. Karadimitris, C. Scott II, D. Netzer, and A. Gany, "Regression and Combustion Characteristics of Boron Containing Fuels for Solid Fuel Ramjets," 26th JANNAF Combustion Meeting, Jet Propulsion Laboratory, Pasadena, CA., 23-27 October, 1989.

C. Vaught, M. Witt, D. Netzer, and A. Gany, "An Investigation of Solid Fuel, Dual Mode Combustion Ramjets," 26th JANNAF Combustion Meeting, Jet Propulsion Laboratory, Pasadena, CA., October 1989.

THESES DIRECTED: J. Nabity, "Metallized Fuel Particle Size Study in a Solid Fuel Ramjet," M.S., September 1989.

M.A. Witt, "Investigation Into the Feasibility of Using Solid Fuel Ramjets for HIgh Supersonic/Low Hypersonic Tactical Missiles," M.S., June 1989.

UNSTEADY HEAT TRANSFER ON TURBINE BLADES

M.F. Platzer, Professor, Aeronautics and Astronautics
Sponsor: NASA Lewis Research Center

OBJECTIVE: Develop a general method for the prediction of heat transfer on turbine blades subjected to flow unsteadiness.

SUMMARY: A general method was developed for calculating the unsteady heat transfer on turbine blades. It is based on the numerical solution of the unsteady boundary layer equation for laminar, transitional, and turbulent flows in combinations with an inviscid unsteady panel code for airfoils in general unsteady motion. Heat transfer rates were calculated for airfoils subjected to a ramp change in angle of attack.

PUBLICATIONS: T. Cebeci and M.F. Platzer, "A General Method for Unsteady Heat Transfer on Turbine Blades," NASA CR-4206, January 1989.

T. Cebeci, R.J. Simoneau, M.F. Platzer, "Unsteady Heat Transfer on Turbine Blades," Journal of Thermophysics and Heat Transfer, forthcoming.

AIRCRAFT AND JET ENGINE UNSTEADY FLOW COMPUTATIONS

M.F. Platzer, Professor, Aeronautics and Astronautics
J.A. Ekaterinaris, Adjunct Professor, Aeronautics and Astronautics
Sponsor: Naval Air Systems Command

OBJECTIVE: Develop computational methods and obtain computational solutions for steady and unsteady flows over fighter aircraft configurations and helicopter blades at high angles of attack and through jet engine compressors and turbines.

SUMMARY: A numerical method for calculating unsteady two dimensional laminar, transitional, and turbulent boundary layers in incompressible flows was developed and applied to a single airfoil changing its incidence angle in time. Two dimensional Navier Stokes computations were completed to obtain the dynamic stall flow patterns on oscillating and rapidly pitching airfoils. A three-dimensional Navier Stokes code was applied to steady flow over a delta wing at high angle of attack and is now being extended to a double delta wing.

PUBLICATIONS: A. Boelcs, T.H. Frannson, M.F. Platzer, "Numerical Simulation of Inviscid Transonic Flow through Nozzles with Fluctuating Back Pressure," ASME Journal of Turbomachinery, vol 111, pp. 169-180, April 1989.

L.W. Carr, M.F. Platzer, M.S. Chandrasekhara, J.A. Ekaterinaris, "Experimental and Computational Studies of Dynamic Stall," Proceedings of the 4th Symposium on Numerical and Physical Aspects of Aerodynamic Flows," Springer Verlag, pp. 239-255, 1989.

CONFERENCE PRESENTATIONS: M.A. Badrinarayanan and M.F. Platzer, "Excitation of Plane Jet by Twin Vane Oscillator," 27th Aerospace Sciences Meeting, Paper No. AIAA 89-0663, January 1989.

RUDDER ROLL STABILIZATION TO IMPROVE SHIP SEAKEEPING

L.V. Schmidt, Professor, Aeronautics and Astronautics

Sponsor: Office of Naval Technology

OBJECTIVE: Improve ship seakeeping by active control means for the purpose of increasing ship operational effectiveness as might be required for encounters in the high sea states of Northern Latitudes.

SUMMARY: The principles of active control using rudder roll stabilization (RSS) were successfully demonstrated in September 1987 by over 200 hours of active digital control of a Spruance class destroyer's rudder system using elementary state variable feedback concepts. This U.S Navy first, digital control of a ship's rudder system, resulted in 40 percent roll motion reductions in operating seaway conditions up to sea state 5. Increasing the roll modal damping from 7 to approximately 35 percent (of critical) by the use of RSS translated to increasing mission operational effectiveness by approximately one sea state, a cost effective option for Navy consideration. Directed funded research work, started in FY90, will support investigations aimed initially at developing an adaptive (digital) filter concept to improve the current, irregular, nonlinear behavior of the steering machinery as found on the Spruance and Ticonderoga ship classes.

PUBLICATIONS: A.E. Baitis and L.V. Schmidt, "ship Roll Stabilization in the U.S. Navy," Naval Engineers Journal, American Society of Naval Engineers, 101, pp. 43-53, May 1989.

CONFERENCE PRESENTATIONS: A.E. Baitis and L.V. Schmidt, "Ship Roll Stabilization in the U.S. Navy," presented at the May 1989 Annual American Society of Naval Engineers (ASNE) Day National Conference, Washington, D.C.

WING ROCK DUE TO INERTIAL COUPLING

L.V. Schmidt, Professor, Aeronautics and Astronautics

OBJECTIVE: Identify the features of aircraft nonlinear flight mechanics which contribute to a limit cycle motion called "wing rock."

SUMMARY: The term "wing rock" is used to describe the rocking motion of an aircraft about its longitudinal axis. Numerous high performance aircraft have shown this trait, usually when in flight near to stall onset. A candidate mechanism for the wing-rock limit cycle is the inertial coupling between an unstable lateral-directional (Dutch Roll) mode with a stable longitudinal (Short Period) mode. Coupling is provided by the nonlinear interactions of inertially related terms in the complete set of motion equations. Dependence of the wing rock amplitude upon the ratio of longitudinal to lateral-directional characteristic frequencies has been demonstrated. Further studies are planned using F-14 aircraft reference data for reasons of Navy relevance.

PUBLICATIONS: L.V. Schmidt, "Wing Rock due to Inertial Coupling, " Proceedings of Symposium on Fluid Dynamics held at CA. Inst. of Tech., World Publishing Co., Forthcoming.

CONFERENCE PRESENTATIONS: L.V. Schmidt, "Wing Rock due to Inertial Coupling," Symposium on Fluid Dynamics held at CA. Inst. of Tech., Pasadena, CA., 17-18 August 1989.

ACTIVE STALL CONTROL

R. P. Shreeve, Professor, Professor, Aeronautics and Astronautics
M.R. Jedwab, Adjunct Professor, Aeronautics and Astronautics
Sponsor: Naval Air Systems Command

OBJECTIVE: Investigate the onset of flow instabilities in a small, centrifugal compressor with a view to operating stably through active control.

SUMMARY: Rotating stall in aircraft compressors during maneuvers or intake distortion can trigger engine surge, structural damage and, possibly can lead to loss of the aircraft. A small turbocharger, driven by compressed air is being used in an experiment in which rotating stall is detected using case mounted semi-conductor pressure transducers with eight channels of spectral analysis. It was shown that rotating stall did not occur before surge was observed in general, and this led to redesign of the compressor casing and outlet geometry. A naturally occurring rotating stall boundary was shown to occur in the new design. Following a more detailed examination of the stall characteristics, active control will be attempted.

PUBLICATIONS: M.R. Jedwab and R.P. Shreeve, "Measurement of Unsteady Aerodynamic Phenomena in Radial Compressor," Technical Report, Naval Postgraduate School, Monterey, CA., (In Preparation).

SURFACE CONTOURING EFFECTS ON FAN SHOCK-BOUNDARY LAYER INTERACTION

R.P. Shreeve, Professor, Aeronautics and Astronautics
Sponsor: Naval Air Systems Command

OBJECTIVE: Investigation of the effect of upstream surface contours on shock-boundary layer interaction in a simulated fan passage.

SUMMARY: The interaction of the passage shock with the blade suction surface boundary layer gives rise to separation and losses, and consequent loss of efficiency, in aircraft engine fans.

A small, two-dimensional transonic blow-down cascade model of a transonic fan tip section is being modified to simulate one blade passage at larger scale. Experiments are planned in which the shock boundary layer interaction will be observed and the shock induced losses measured when changes are made in the upstream surface geometry. The transonic cascade was located and installation of a new control valve and data system was started.

FAN AND COMPRESSOR STALL

R. P. Shreeve, Professor, Aeronautics and Astronautics
I.N. Moyle, Ph. Candidate and G.J. Walker, Senior
Lecturer in Mechanical Engineering, University of Tasmania, Australia
Sponsor: Naval Air Systems Command

OBJECTIVE: Investigate those phenomena which currently limit the off-design stable operating range of aircraft axial compressors and fans.

SUMMARY: Two tasks have been defined. First, in a large subsonic cascade wind tunnel, off-design flow and the onset of stall in controlled-diffusion compressor blading has been measured in detail using a two component LDV system. The goal is the calibration of viscous codes to be used in the development of separation resistant cascade geometries. During 1989, hardware and software to enable programmed flow traversing with automatic data acquisition was completed and the ability to measure loss coefficients using calibrated pressure probes was restored. Preliminary data were obtained near to stall. Second, the effects of tip-gap changes on the flow field in a multi-stage axial compressor have been measured in a 3 foot diameter machine. The observations, using steady state (pneumatic) and unsteady instrumentation (semi-conductor wall static pressure and shear gauges), have led to an improved understanding of the flow near the case wall and to the identification of a controlling wall shear parameter.

PUBLICATIONS: G.J. Walker, "Transitional Flow on Axial Turbomachine Blading," AIAA Journal, vol. 27, no. 5, pp. 595-602, 1989.

CONFERENCE PRESENTATIONS: Y. Elazar and R.P. Shreeve, "Viscous Flow in a Controlled Diffusion Compressor Cascade with Increasing Incidence," ASME Paper no. 89-GT-131, presented at the ASME 33rd International Gas Turbine and Aeroengine Congress and Exhibition, Toronto, Canada, June 5-8, 1989.

I.N. Moyle, "Influence of the Radial Component of Total Pressure Gradient on Tip Clearance Secondary Flow in Axial Compressor," ASME Paper no. 89-GT-19, presented at the ASME 33rd International Gas Turbine and Aeroengine Congress and Exhibition, Toronto, Canada, June 5-8, 1989.

THESES DIRECTED: K.D. Murray, LT, USN, "Automation and Extension of LDV Measurements of Off-Design Flow in a Cascade Wind Tunnel," M.S., June 1989.

P.H. Yeo, "Review and Evaluation of a Turbomachinery Through Flow Finite Element Code, M.S., June 1989.

M.A. Classick, "Off-Design Loss Measurements in a Compressor Cascade," M.S., September 1989.

CONTROL FOR HELICOPTER VIBRATIONS, PERFORMANCE, AND ACOUSTICS

R.E. Wood, Professor of Aeronautics and Astronautics
R. Kolar, Professor of Aeronautics and Astronautics

OBJECTIVE: The McDonnell-Douglas/Army/NASA OH-6A helicopter was flight tested using Higher Harmonic Control for reducing the vibrations. Present research is directed in establishing programs in understanding the vibration reductions using methods of chaos, and enhancement of performance by using theoretical approach. For all of the work, initial computations will be based on the actual flight test data supplied by MDHC. The project also includes building a model Unmanned Air Vehicle (helicopter) with HHC system to investigate various phenomenon.

OBJECTIVE: Preliminary investigation on the methods of chaos applied to higher harmonic control provided good insight into the vibration reduction obtained. The method, applied for the first time to investigate flight test data, also provides tools to design controllers for HHC and yiled limited on the maximum vibration reduction obtainable from HHC. The UAV-Helo is acquired, and preliminary testing to ascertain its dynamic characteristics is complete. The HHC system for the four-bladed helicopter is being worked on.

DEPARTMENT OF ADMINISTRATIVE SCIENCES

DEPARTMENT OF ADMINISTRATIVE SCIENCES

The Department of Administrative Sciences is responsible for academic programs designed to educate officers and DoD civilian employees in a variety of functional management specialties. The diversity of the faculty's professional expertise and scholarship is reflected in the wide variety of research projects conducted in the department.

In addition to permanent faculty, the department's research efforts were augmented by, and benefitted from, the participation of a number of adjunct professors. The research projects cover a broad range of public sector management issues, ranging from basic scholarly research projects to applied research designed to assist policy and operational decision making. For ease of exposition the research projects are grouped into the following areas: acquisition; logistics and transportation; computers, information, and communication systems; financial management; manpower, personnel, and training analysis, and policy analysis and management.

Acquisition

Professors D. Boger and S. Liao continued a multi-year project under the sponsorship of the Naval Air Systems Command. The objective of the project is to develop parametric cost estimation models for aircraft modification (MOD) programs. In this phase, data on twelve MOD programs were gathered for the research data base. With sponsorship of the Naval Center for Cost Analysis, Professor Boger is preparing a monograph on competition in weapon system acquisition. Professor W. Gates received NPS Research Council support to develop a model of the principal-agent relationship in the DoD acquisition process. With support from the NAVSEA Cost Estimating and Analysis Division, Professor O. Moses started research on measuring extensions in technology of state-of-the-art systems and analysis of the relationship between technology and cost. The research program in acquisition will be augmented with the addition of new faculty.

Logistics and Transportation

Research in logistics focuses on providing support to the Supply Corp in inventory modeling. Professor A. McMasters continued his long-term research effort to develop improved wholesale inventory models under the sponsorship of Navy Fleet Material Support Office. He also completed the third phase of another project to develop expert systems to facilitate decision making by inventory managers at Navy Stock Points, concentrating on managing of hazardous materials. Under NPS Research Council funding, Professor D. Trietsch studied efficient transfer lots in multi-department job shops or multi-machine shops. In addition, he started a project for the Naval Sea Systems Command focusing on prioritizing set-up reduction times in shipyard repair operations.

Computers, Information and Communication Systems

The NPS Research Council supported the research efforts by three faculty members. Professor M. Zviran completed a project which utilized Multiple Criteria Analysis to evaluate the selection of computer hardware. He started research on the characteristics of user passwords and evaluation of alternative authentication techniques. Professor G. Fann started research into the effectiveness of communication strategies on the implementation of organization-wide changes. Professor M. Kamel began work on the performance of view processing under different materialization strategies. Also, Professor M. Kamel continues collaborative work with Professor D. Hsiao of the Department of Computer Science in the development of a single database system capable of executing transactions written in different data languages and supporting database structures of their corresponding data models.

Professor T. Abdel-Hamid initiated a project for the Naval Center for Cost Analysis which examines use of expert systems in cost estimation of software development. Professors N. Schneidewind and T. Abdel-Hamid continued work for the Navy Management Systems Support Office involving development of a software quality metrics methodology and enhancement of a software reliability model.

Professors D. Dolk and B. Frew continued the development of the Emergency Preparedness Management Information System decision support system for maintaining communications during a national emergency. This is a multi-year project supported by the National Communications Systems. In addition, Professor Frew performed research on the paperless fleet operations through optical storage, networks and other applications of technology. This work was funded by the Naval Data Automation Command. Professor J. Suchan was supported by the Defense Personnel Security Research and Education Center (PERSEREC) to conduct an analysis of field agents and adjudicators written communication skills to determine if their reports of investigation were easy for adjudicators to read and comprehend.

Financial Management

Professor K. Euske collaborated with Professor Dolk in a project analyzing the management control and information system implications of Navy's RAMP Project. Also, Professors Euske and L. Jones continued a study to analyze the impact of budget issues on squadron operations of the Pacific Fleet Naval Air Forces. Professors Euske and J. McCaffery continued analyzing the effect of the resource allocation process on CINCPACFLT. Professor L. Jones continued a project, under the sponsorship of the Department of the Navy Office of the Comptroller, to formulate and test hypotheses to explain the increase in Congressional control of Navy budget execution documented to have occurred since the late 1960s.

Manpower, Personnel, and Training Analysis

The US Army Recruiting Command continued to sponsor the manpower research program in the department. During AY1989, six projects were funded. Investigators include Professors G. Thomas, S. Mehay, L. Solnick, M. Eitelberg, B. Roberts, T. Moore, K. Kocher, L. Johnson and L. Gorman. These studies cover a wide range of recruiting issues, including recruiting in the 21st century, the development of management decision models for local labor market analysis, the comparison of the demographics and enlistment motivations of Army reserve enlistees and Army National Guard enlistees, the determination of the desired level of female participation in the reserves, analyzing the loss profiles of Army Nurse Corps officers assigned to Reserve Centers, the development of local measures of Qualified Military Available and Interested (QMA&I) for the Year 2000, second generation estimates of QMA&I for the year 2010, and the analysis and comparison of patterns of geographic transfers within the US Army Reserve as well as civilian labor migration from place to place.

Professors G. Thomas and L. Gorman initiated a research project for the Naval Recruiting Command focusing on USN QMA&I. Under the sponsorship of Deputy Chief of Naval Operations (Manpower), Professor D. Henderson examined the economics of national service and examined the issue of accounting for inflation when calculating present values. Professor M. Eitelberg began evaluating the effects of different personnel procurement systems on defense manpower quality for the Office of the Assistant Secretary of Defense (Force Management and Personnel). Professor R. Elster held the Chair of Manpower, Personnel and Training Analysis.

Policy Analysis and Management

Professor N. Roberts continued work with Professors J. Tritten, Department of National Security Affairs, and D. Whitt, Defense Resources Management Center, on strategic management for the Department of Defense. This project has several sponsors within the Office of the Secretary of Defense. Professors R. Evered and J. San Miguel completed a project to design and evaluate management systems for the Naval Industrial Improvement Program focusing primarily on the management of the shipyards. Professor D. Henderson examined the evidence bearing on the supply-side economists' claim that cuts in the marginal tax rates for the highest-income taxpayers caused little or no loss in tax revenue for the Federal government. He also analyzed the microeconomics of a variable import fee on oil. Professors K. Thomas and B. Roberts were supported by the Naval Avionics Center to measure behavioral and attitudinal factors that influence the effectiveness of civilian personnel and engineering units.

ENHANCING THE PORTABILITY OF QUANTITATIVE SOFTWARE ESTIMATION MODELS

Tarek K. Abdel-Hamid, Associate Professor of Administrative Sciences
Sponsor: NPS Research Council

In this study we propose the use of an extensive simulation model of the software development process to identify aspects of an organization's managerial environment that have a significant impact on the cost of software development, and to quantify the degree of that impact. The results of this study should help improve both the accuracy as well as the portability of software estimation models.

PUBLICATION: T.K. Abdel-Hamid and S.E. Madnick, "Lessons Learned from Modeling the Dynamics of Software Project Management," Communications of the ACM, December 1989.

INVESTIGATING THE INCORPORATION OF EXPERT SYSTEMS TECHNOLOGY INTO SYSTEM DYNAMICS SIMULATION MODELING

Tarek K. Abdel-Hamid, Associate Professor of Administrative Sciences
Sponsor: NPS Research Council

In this research effort we investigated the feasibility as well as the utility of incorporating an expert system module for human resource planning in a system dynamics model of software project management. The implications of capturing such decision making processes in a rule-based knowledge-base, rather than using the traditional representation procedural code were analyzed from two viewpoints: model development (e.g., the flexibility of PROLOG rules versus a representation in procedural DYNAMO code), and model use (e.g., the user-machine interface).

CONFERENCE PRESENTATION: T.K. Abdel-Hamid, "On the Utility of Historical Project Statistics for Cost and Schedule Estimation," The 23rd DoD Cost Analysis Symposium, September 4-8,1989.

INCORPORATING EXPERT SYSTEMS TECHNOLOGY INTO A SYSTEM DYNAMICS COST ESTIMATION MODEL FOR SOFTWARE DEVELOPMENT

Tarek K. Abdel-Hamid, Associate Professor of Administrative Sciences
Sponsor: Naval Center for Cost Analysis

In this research effort we investigated the feasibility as well as the utility of incorporating expert system modules for human resource planning and quality assurance resource allocation in a system dynamics cost estimation model for software development. The implications of capturing such decision making processes in a rule-based knowledge base, rather than using the traditional representation in procedural code were analyzed from two viewpoints: model development (e.g., the flexibility of PROLOG rules versus a representation in procedural DYNAMO code), and model use (e.g., the user-machine interface).

PUBLICATION: T.K. Abdel-Hamid, "A Study of Staff Turnover, Acquisition, and Assimilation and their Impact on Software Development Cost and Schedule," Journal of Management Information Systems, September 1989.

IMPROVING SOFTWARE COST AND SCHEDULE ESTIMATION THROUGH THE NORMALIZATION OF HISTORICAL PROJECT STATISTICS

Tarek K. Abdel-Hamid, Associate Professor of Administrative Sciences
Sponsor: Naval Center for Cost Analysis

SUMMARY: The objective of this research task is twofold. First, we demonstrate that raw historical project statistics are inadequate benchmarks for future estimation of software projects. Second, we develop a system dynamics-based normalization engine to process raw project results and derive a normalized set of values to be used as benchmarks for future estimation.

PUBLICATION: T.K. Abdel-Hamid, "The Dynamics of Software Project Staffing: A System Dynamics Based Simulation Approach," IEEE Transactions on Software Engineering, February 1989.

IMPACT OF COMPETITION ON WEAPON SYSTEM ACQUISITION

D.C. Boger, Associate Professor of Economics,
Department of Administrative Sciences
Sponsor: Naval Center for Cost Analysis

OBJECTIVE: To publish a monograph, to be edited by the investigator, containing relevant work on competition in weapon system acquisition.

SUMMARY: This project revolves around the research, assembly, editing, and production of a monograph from all papers concerning the impact of competition on weapon system acquisition which were presented at several sessions of the 23rd Annual DoD Cost Analysis Symposium held in September 1989. All potential authors have been contacted for paper contributions and editing of the papers has begun. The monograph will be completed in the next reporting period.

PUBLICATION: A monograph, to be issued as an NPS Technical Report, is in progress.

CONFERENCE PRESENTATION: D.C. Boger, W.R. Greer, and S.S. Liao, "Competition in Defense Acquisition: Myths and Facts," DoD Cost Analysis Symposium, Washington, DC, 6--8 September 1989.

DATA AND METHODS FOR ESTIMATING COSTS OF AIRCRAFT MODIFICATIONS AND DERIVATIVES

D.C. Boger, Associate Professor of Economics,
and S.S. Liao, Professor of Accounting,
Department of Administrative Sciences
Sponsor: Naval Air Systems Command, Cost Analysis Division

OBJECTIVE: To develop databases and parametric cost estimating models for aircraft modifications and derivatives.

SUMMARY: In the prior reporting period of this multi-year project, a survey of data availability and the formulation of a cost element structure were completed, with initial data acquisition begun. During this reporting period, data on twelve aircraft modification/derivative programs were obtained via student and principal investigator visits to contractor sites, with initial database development begun. Methods development and further database development will occur in later periods.

PUBLICATION: Aircraft Modifications Cost Analysis (Interim Report) is under review by the sponsor. An NPS Technical Report will be issued upon sponsor's approval.

CONFERENCE PRESENTATION: D.C. Boger and S.S. Liao, "Aircraft Cost Modification Study," U.S. Air Force Systems Command, Aeronautical Systems Division (ASD)/Industry Cost Analysis Workshop, Monterey, CA, 18--20 April 1989.

THESES DIRECTED: J.M. Hughes, LT, USN, H. Blaylock, III, LCDR, USN, R.H. Busick, Jr., Capt., USMC, and W.D. Jensen, LCDR, USN, "Data Base Formation and Analysis for Cost Estimation of Aircraft Modifications and Derivatives," Master's Thesis, June 1989.

J.C. Boyce, LCDR, USN, T.D. Amyx, Maj., USMC, A.S. Hankins, LT, USN, and G.M. Lancaster, LT, USN, "Data Base Development and Evaluation for Cost Estimation of Aircraft Modification Programs," Master's Thesis, December 1989.

ANALYSIS OF THE MANAGEMENT CONTROL AND INFORMATION SYSTEM IMPLICATIONS OF RAMP

D. R. Dolk, Associate Professor of Information Systems
K. J. Euske, Associate Professor of Accounting
Department of Administrative Sciences
Sponsor: Commander, Naval Supply Systems Command
Mr. Robert Houts (NAVSUP PML 5505)

OBJECTIVE: The RAMP Project within the Navy is concerned with developing highly automated manufacturing facilities using advanced robotics. A prototype facility currently exists. A full scale operating facility is being constructed. Information and accounting systems in the U.S., both in the private and public sectors, are not designed to support this technology. This project is designed to systematically analyze the information needs for efficient and effective resource allocation and control of such facilities. The specific goals of this research project are to: (1) Analyze the current management control and information systems currently in place to support the RAMP project. (2) Recommend adjustments to those systems such that the output of those systems will provide information that accurately appraises the RAMP project. (3) Ensure that the systems provide valid and reliable information regarding the cost, effectiveness, and efficiency of the RAMP project. The project is still in process. We anticipate to continue this project through September 1991.

SUMMARY: The accounting and reporting requirements for the system have been developed. Compatibility of these requirements with existing Navy systems have been analyzed. Currently, operational specifications are being developed for the system. A relational database system is being used to implement an activity-based accounting model in the CIM environment. Prof. Dolk is responsible for coordinating the dictionary and database administration aspects of this implementation.

CONFERENCE PRESENTATIONS: D.R. Dolk and K. Euske, "Management Control Structures in a CIM Environment," ORSA/TIMS Vancouver, May 8-10, 1989.

D.R. Dolk,"Self-Referential Dictionary System for Heterogeneous Databases," (Invited). ORSA/TIMS Vancouver, May 8-10, 1989.

THESES DIRECTED: LCDR M.H. Barber, USN and LT. P.R. Richey, USN, "Naval Supply Systems Command: Data Administration Planning and Implementation," Master's Thesis; March 1989.

A DECISION SUPPORT SYSTEM FOR EMERGENCY COMMUNICATIONS

D. R. Dolk, Associate Professor of Information Systems
Department of Administrative Sciences
Barry Frew, Assistant Professor of Information Systems
Department of Administrative Sciences
Sponsor: National Communications Systems

OBJECTIVE: This project is involved with the development of the EPMIS (Emergency Preparedness Management Information System) decision support system for maintaining communications during a national emergency. It is an ongoing effort in which NPS has participated the past four years. NPS' involvement is threefold: (1) Serve as an internal validation and verification agent to NCS upon the design of the overall system which they have contracted out to several subcontractors. (2) Develop a more realistic damage assessment module for the EPMIS than currently exists and a simulation based tutorial which exercises this model. (3) Investigate the feasibility of incorporating optical disk technology into the EPMIS architecture.

SUMMARY: A thorough analysis of the database design has taken place and several recommendations have been made with regard to redesigning the physical structures of the EPMIS database. An analysis of the XTRAM resource allocation expert system was made and a recommendation to rehost it in the NEXPERT OBJECT software program was made in order to facilitate system integration. A VNTK-based damage assessment model was developed and tested to replace the existing damage assessment model in EPMIS. A functional design for the EPISODE simulation tutorial has been developed and an early prototype demonstrated to the sponsor. A CD-ROM optical disk unit has been attached to a portable Compaq 386 computer to show proof-of-concept of using this technology in a "fly away" kit. The database design and XTRAM analyses were performed by Prof. Dolk. The damage assess ment module and EPISODE simulation have been developed under Professor Frew merged the optical disk technology with the current "fly away", portable computer.

THESES DIRECTED: W. Short, LT, USN, and J. Bockenek, LT, USN, "Analysis of the EPMIS Data Base," M.S., September 1989.

V. Micucci, LT, USN, "Analysis of XTRAM, An Expert System for the Emergency Allocation of Telecommunications Resources," M.S. September 1989.

CONFERENCE PRESENTATION: "Self-Referential Dictionary System for Heterogeneous Databases," (Invited). ORSA/TIMS Vancouver, May 8-10, 1989.

THE EFFECTS OF DIFFERENT PERSONNEL PROCUREMENT SYSTEMS ON DEFENSE MANPOWER QUALITY

Mark J. Eitelberg, Associate Professor of Administrative Sciences
Sponsor: Office of the Assistant Secretary of Defense
(Force Management and Personnel), Directorate of Accession Policy

OBJECTIVE: To develop several models of conscription and national service, for use in a policy analysis that would weigh the costs and benefits of alternatives to all-volunteer recruiting--with primary emphasis placed on the strengths and weaknesses of selected options in achieving manpower quality objectives under a variety of circumstances.

SUMMARY: Research on the project has been extended into fiscal 1990, and the focus has shifted to the effects of defense manpower policies (not limited to procurement alone) on the quality of the force. This change was made because recent international events have greatly diminished the likelihood of large-scale experimentation with new forms of personnel procurement. A longitudinal analysis revealed that many of the military's most able people are leaving highly technical jobs at a rate that is higher than for the military as a whole. A study of the demographic characteristics of military personnel discounted the practical utility of policies aimed at achieving "representativeness," including recent proposals for national service. Finally, an examination of the social role of the military suggested that there will be increasing attempts made over the next several years to use the armed forces as an agent of social change, along with growing interest in recruiting marginally-qualified manpower for military service.

PUBLICATIONS: J.L. Laurence, "Enlisted Personnel Quality: Changes and Consequences," HII-89-23, Alexandria, VA., HumRRO International, Inc., August 1989.

A. Crawford, "Projected Effects of The Proposed Citizen Corps Program on Social Representation in the Military," Monterey, CA, Naval Postgraduate School, forthcoming.

CONFERENCE PRESENTATIONS: M.J. Eitelberg, "Military Representation: Reflections and Random Observations," Biennial Conference on Armed Forces and Society, Baltimore, MD, October 1989.

M.J. Eitelberg, "War or Welfare: The Military as an Agent of Social Change," Biennial Conference on Armed Forces and Society, Baltimore, MD, October 1989.

M.J. Eitelberg, "Military Representation: Reflections and Random Observations," 97th Annual Convention of the American Psychological Association, New Orleans, LA, August 1989.

M.J. Eitelberg, "Aptitude Test Scores of Military Personnel Assigned to C^3I Jobs: Trends and Prospects," 43rd International Convention and Exposition of the Armed Forces Communications and Electronics Association, Washington, D.C., June 1989.

THESES DIRECTED: T. Beaty, CPT, USMC, "A Study of Factors Influencing the Reenlistment Decisions of First-Term Marines," Master's Thesis, December 1989.

A. Dropp, LT, USN, "Unit Cohesion and the Navy: Does Cohesion Affect Performance?" Master's Thesis, December 1989.

W. Kear, LCDR, USN, "Surface Warfare Attrition: Does Ship Type Make a Difference?," Master's Thesis, December 1989.

R. Crowe, LCDR, USN, "An Analysis of a Proposed Navy College Fund," Master's Thesis, December 1989.

T. McManus, LCDR, USN, "An Analysis of the Navy Sea College Program," Master's Thesis, December 1989.

J. Jarvis, LT, USN, and R. Gaines, LT, USN, "A Structure for Analyzing the First-Term Training Performance of Hispanic Recruits in the Navy," Master's Thesis, December 1989.

DESIGN AND EVALUATION OF MANAGEMENT SYSTEMS FOR NAVAL INDUSTRIAL IMPROVEMENT

Roger Evered, Professor of Management,
Joseph G. San Miguel, Professor of Accounting
Department of Administrative Sciences
Sponsor: Under Secretary of the Navy, Naval Industrial Improvement Program

OBJECTIVE: To evaluate the effectiveness of the current management systems used by the Navy industrial activities. These systems include the strategic policy and planning system, the organizational structure, the internal reporting system, and the performance evaluation system.

SUMMARY: Available information on the Department of the Navy's industrial activities was obtained from relevant sources including top officials' reports and policy statements. Reports of outside consultants were critically analyzed. The practices of private companies were used for comparative purposes. Interviews were held at a representative sample of public and private shipyards. Also, interviews were held with Flag and Secretariat level officials including Naval Sea Systems Command Headquarters, the Comptroller Office, Office of Naval Operations for Logistics, and several others involved in the corporate management process. An analysis of the key corporate management issues was prepared and findings and recommendations were made to both the sponsor and relevant Flag officers involved in improving public shipyard performance. In addition, a critical review of the Ship Depot Maintenance Study Report tasked by the CNO was presented to OPNAV 04 and to the sponsor at SECNAV. Guidance and source materials for improving the shipyards' strategic planning was provided to the NAVSEA 07.

PUBLICATIONS: R. Evered and J.G. San Miguel, "Implementing Strategic Planning for the Naval Shipyards," Case Study (in progress).

R. Evered, and J.G. San Miguel, "Establishing a Board of Directors Function for the Naval Shipyards: Promises and Pitfalls," Naval Institute Proceedings (in progress).

R. Evered and J.G. San Miguel, "Implementing New Management Programs in the Navy: The Case of the 'Managing to Payroll' Program," Public Administration Review (in progress).

THESES DIRECTED: J.S. Mikac, LCDR, USN, "Barriers to Effective Program Implementation in the Navy: The Case of Managing to Payroll," Master's Thesis, December 1988.

J. Taylor, LCDR, USN, "Cost Differences in Overhauling Naval Ships in Commercial versus Naval Shipyards," Master's Thesis, December 1988.

DATA COMMUNICATIONS SUPPORT

Barry Frew, Assistant Professor of Information Systems
Sponsor: Naval Data Automation Command, Washington DC

OBJECTIVE: Evaluate uses of optical storage, including investigation of hypertext access methods, networking of optical devices, and premastering processes for CD-ROM. Prototypes for boilerwater feedwater pump maintenance, and management of naval messages were supported by this research. A CD Pre-mastering machine was installed and will be used in further research to develop actual data disks for fleet applications.

THESES DIRECTED: Mark Brown, "Requirements Analysis for Converting DMDC Files to Optical Storage," MIS, March 1989..

Bruce France, LCDR, USN, "Moving Optical Technology In-House," MIS, March 1989.

Daniel Kellett, LT, USN "Hypertext: An Approach to a Paperless Navy," MIS, March 1989.

Robert Taylor, LCDR, USN, "Conversion of Hard Copy Documents to Digital Formats Using Scanners," MIS, March 1989.

James Hoge, LT, USN, "Use of Optical Storage Devices as Shared Resources in Local Area Networks," MIS, September 1989.

R.C. Gotlick, LT, USN, E.A. Victoriano, LT, USN,, "A Study of Shipboard Supply Processes and Optical Storage," FIN, December 1989.

A MODEL OF THE PRINCIPAL-AGENT RELATIONSHIP IN THE DEPARTMENT OF DEFENSE ACQUISITION PROCESS

W. R. Gates, Adjunct Professor of Economics
Sponsor: NPS Research Council

OBJECTIVE: Develop a model of the principal-agent relationship that is more directly applicable to the Department of Defense acquisition process.

SUMMARY: Failure of procurement reform to eliminate the perceived procurement process inefficiencies has lead to a growing sense of mistrust between Congress, OSD, the Services, and contractors. Improving the procurement process seems impossible as long as there is a sense of mistrust. Literature on principal-agent relationships was examined to determine if it could be applied to the defense acquisition process. While it appears that agency theory can be applied, this research indicated several areas where this theory needs to be extended. Also examined were alternative approaches to managing the principal-agent relationship, to compare and contrast agency theory, transaction costs economics, and total quality management. Paper to be written and submitted for publication during 1990.

PUBLICATIONS: W. Gates, "Department of Defense Procurement Policy Reform: An Evolutionary Perspective," Journal of Cost Analysis, Fall 1989.

W. Gates, "Incentive Contracting and Principal-Agent Theory: Theory Is Nice But Can It Be Applied?" Submitted for publication.

ASSESSING THE EFFECTIVENESS OF OFFICE AUTOMATION: SACONS IN THE NAVY

William James Haga, Lorraine Davis, Robert Murphy
Department of Administrative Sciences
Sponsor: None

OBJECTIVE: Quantify the productivity impact of the automation of office work procedures using a pretest/posttest one-group research design that measured inputs (size of staff, grade structure, usage of overtime), outputs (workload, quality of service) and social by-products (morale, teamwork, professionalism) using archival data supported (in the case of social by-products) with survey responses.

SUMMARY: This is a follow-on to last year's study of the installation of the Standard Automated Contracting System (SACONS) contract-generation system at the Directorate of Contracting at Fort Ord. We observed the implementation of the SACONS program in the supply department of the Naval Postgraduate School, the first Navy supply activity to use SACONS. While workload increased slightly the size of the staff also increased after the SACONS automation, although the grade structure remained about the same. Nonetheless, the procurement action lead time, the conventional user-oriented measure of the quality of service for supply activities, improved after automation. The findings, however, were confounded when the NPS supply activity lost its procurement authority in the early part of the year following an IG inspection. This resulted in a slow-down when purchases were channeled through a special procurement official for the three-month duration of the suspension. When the suspension was lifted in the summer of 1989, there was surge of back-logged procurement activity which was attended by a temporary swell in usage of overtime work. A follow-on study of the NPS SACONS installation is planned for 1990 to provide a stable basis of comparison to the pre-SACONS period.

THESIS DIRECTED: L.S. Davis, LT, USN, and R.P. Murphy, LT, USN, "Personal Computer Use in Navy Field Activities: A Productivity Study," M.S., December 1989.

PERSONALITY TYPE AND COMPUTER USAGE

William James Haga
Department of Administrative Sciences
Sponsor: None

OBJECTIVE: Empirically test the folk stereotype of computer people as introverted, cerebral, insensitive and socially inept, using the standard Myers-Briggs Personality Type Indicator (MBTI) along with a survey questionnaire gauging affinity for computers. Indicators are ownership of a PC, use of procedure-oriented programming languages and knowledge of a set of advanced computer procedures scaled for difficulty. The MBTI sorts personality types on four polar dimensions: Introversion-Extroversion, Sensing-Intuition, Thinking-Feeling and Judgment-Perception. The computer affinity survey divides subjects into high affinity and low affinity although responses are recorded on a continuum. Subjects with a high affinity for computers to be clustered with personality types that matched the stereotype of the computer nerd: strong introversion/weak extroversion, strong thinking/low feeling and strong judgment/weak perception. No predictions were made about the Sensing-Intuition dimension.

SUMMARY: Following on the work done in 1988, in 1989 I continued to administer the MBTI instrument and the affinity survey to NPS students in my classes and those of cooperative colleagues. The sample size is now over 300. Last year, preliminary analysis of early responses found that the distribution of personality types in the NPS sample approximated that of U.S. college graduates. No strong Pearson zero-order correlations were found between any of the MBTI polar types and the continuum of computer affinity. If the preliminary findings hold up in further analyses, the finding will be that there is no relationship between personality type as measured by the MBTI and an affinity for computers. The stereotype of computer users as socially-deficient geeks has no empirical basis. Apparently, all kinds of people like computers just as all kinds of people avoid them. No further analyses were attempted in 1989.

INFORMATION SYSTEM EFFECTIVENESS: RESEARCH DESIGNS FOR CASUAL INFERENCE

William James Haga, Moshe Zviran and M. Agus Mustofa
Department of Administrative Sciences
Sponsor: None

OBJECTIVE: Examine the extent to which studies of information system (IS) effectiveness can support the establishment of causal inference.

SUMMARY: A review of 36 empirical studies of IS effectiveness over the past 20 years found that 97% of them, by virtue of deficient research designs, provided no basis for causal inference. 89% of the studies were vulnerable to at least one of eight threats to internal validity, rendering it problematic whether IS effectiveness research can exclude rival explanations of reported findings. It was a rare study of system performance that could demonstrate with certainty that its results mean what the researchers claimed. These findings erode a basis for the construction of formal theory that can describe, explain or predict behavior around information systems. Three follow-on studies have emerged from this work: 1. Variety of Definitions of Information System Effectiveness. 2. Assessing Information System Effectiveness: Data Collection Techniques. 3. Development of Post-Positivist Methods in Information Systems Research.

PUBLICATION: W.J. Haga and M. Zviran, "Information System Effectiveness: Research Designs for Causal Inference," Submitted to Information Systems Research.

THESES DIRECTED: M. Agus Mustofa, CPT, Indonesian Air Force, "A Dity of Empirical Studies of Information System Effectiveness," M.S., June 1989.

COGNITIVE PASSWORDS

Moshe Zviran, William James Haga and John D. Hulsey
Department of Administrative Sciences
Sponsor: Naval Postgraduate School Research Council

OBJECTIVE: A preponderance of computer systems use passwords as a means to authenticate the legitimacy of people attempting to gain access. Passwords, however, are stuck in a dilemma. A difficulty with passwords is remembering them. If they are made easy to remember, then they are also rendered easy for others to guess. If they are made difficult to guess then they return to being difficult to remember. This leads to them being written down, which converts a password from something remembered to something possessed. As soon as people take to writing down passwords, they are vulnerable to easy discovery. Cognitive passwords aim to overcome the dilemma of conventional passwords. In a cognitive password scheme, a user provides a system with answers to 20 questions. The questions are themselves chosen by the user and are based on highly personal facts or preferences that only the user would know. For example, a user's favorite color or the name of his or her favorite teacher in high school. Once the 20 questions and their answers are imbedded in a computer's access system, a user accessing the computer will be asked a random subset of five questions out of the 20. Correct responses to all five queries will permit access. In this study, 207 respondents were provided with (a) a system-generated conventional password, (b) a conventional password created by each respondent and (c) a set of 20 cognitive items with personalized responses by each user. After a three-month interval, the respondents were asked to recall their system-generated password, their self-created password and their 20 cognitive item responses. At the same time, one person close to each respondent (spouse, friend, relative) was asked to guess the respondent's answers to the cognitive items.

SUMMARY: After three months, no more than 24% of the respondents could recall their system-generated passwords. 80% of those that did recall it had written it down. Over the same period, no more than 31% could recall their self-created passwords. 16% of them had written down their self-created passwords. By comparison, on average, 78% of the respondents recalled their cognitive items. Of the cognitive items that were fact-based (as opposed to being based on preferences), 88% could recall them. Of the people close to the respondents, they could, on average, guess no more than 33% of the respondent's answers. Only one spouse guessed as many as 15 of a respondent's 20 responses correctly. These findings demonstrated that while cognitive passwords are easy for respondents to recall, they are difficult for even socially-close people to guess.

PUBLICATIONS: W.J. Haga and M. Zviran, Department of Administrative Sciences Working Paper No. 89-06, "Cognitive Passwords: From Theory to Practice," May, 1989.

W.J. Haga and M. Zviran, "Data Processing and Communications Security," Volume 13, Number 3 (Summer, 1989), p. 19-23.

W.J. Haga and M. Zviran, "Cognitive Passwords: Key to Easy Access Control," Computers and Security Forthcoming, March 1989

THESIS DIRECTED: J.D. Hulsey, LT, USNR, "Cognitive Passwords: Key to Effective Access Control," M.S., September 1989.

AN ECONOMIC ANALYSIS OF NATIONAL SERVICE

D.R. Henderson, Associate Professor of Administrative Sciences
Sponsor: Deputy Chief of Naval Operations (Manpower)

OBJECTIVE: To analyze the economics of national service.

SUMMARY: The increased budget cost of the non-military youth component of Senator Sam Nunn's National Service proposal is conservatively estimated to exceed the benefits by about $0.9 billion to $2.1 billion annually. Including the losses to youth themselves drives the net cost estimate even higher. An alternative proposal is made to replace grants and subsidized loans with market-rate loans. That way, those who are given gifts that help them develop their earning power and earn more than those who don't go to college would have to pay the gift back.

PUBLICATIONS: D.R. Henderson, "The Case for National Service," a review of A Call to Civic Service by Charles Moskos, Fortune, January 1, 1990.

D.R. Henderson, "Who Needs a Citizens Corps?" Barron's, April 24, 1989.

CONFERENCE PRESENTATIONS:
D.R. Henderson, "An Economic Analysis of National Service," Eleventh Annual Research Conference of the Association for Public Policy and Management (APPAM), Washington, D.C., November 2-4, 1989.

D.R. Henderson, "The Case Against National Service," a Comment on a paper by Charles Moskos, Hoover Institution Conference on National Service, Stanford, CA, September 8-9, 1989.

HOW TO ACCOUNT FOR INFLATION WHEN TAKING PRESENT VALUES

D.R. Henderson - Associate Professor of Administrative Sciences
Sponsor: Deputy Chief of Naval Operations (Manpower)

OBJECTIVE: To determine and to demonstrate how to calculate present values when inflation is expected.

SUMMARY: This paper shows that there are two right ways to discount when you expect inflation. The first is to build an inflation factor into your future cost data for expected inflation and to likewise adjust your interest rate for expected inflation, that is, to include an inflation premium in your interest rate. The second is to ignore expected inflation and to use a discount rate that includes no premium for expected inflation. This paper also shows that this method is invariant to whether you expect changes in the relative price of items.

PUBLICATION: D.R. Henderson, "How to Account for Inflation when Taking Present Values," written but not yet submitted.

THESIS DIRECTED: R. Lang, LT, USN, "Economic Analysis of ADP Acquisition," Master's Thesis, September 1990.

THE PERVERSE EFFECTS OF A VARIABLE OIL IMPORT FEE

D.R. Henderson, Associate Professor of Administrative Sciences
Sponsor: None

OBJECTIVE: To analyze the effect of a variable import fee on oil.

SUMMARY: A variable import fee on oil (VIF) was found to be very perverse. The VIF was shown, under a wide range of assumptions, to cause the elasticity of demand facing oil-exporting countries to fall. Thus, oil exporters with some degree of monopoly power would have a strong incentive to raise their price. The country imposing the VIF would then not receive as much revenue from the VIF as if it simply set a flat import fee that obtained the same domestic price.

PUBLICATIONS: D.R. Henderson, "VIF Mortis Est: A Rejoinder to Singer," The Energy Journal, Vol. 10, No. 4, October 1989, pp. 173-174.

D.R. Henderson, "The Perverse Effects of a Variable Oil Import Fee," The Energy Journal, Vol. 10, No. 4, October 1989, pp. 159-170.

ARE WE ALL SUPPLY-SIDERS NOW? THE EMERGING CONSENSUS ON MARGINAL TAX RATES

D.R. Henderson - Associate Professor of Administrative Sciences
Sponsor: None

OBJECTIVE: To present and assess the evidence bearing on the supply-siders' claim that an x percent drop in tax rates would cause a much less than x percent drop in tax revenues. Also to assess whether there is a consensus on the importance of marginal tax rates.

SUMMARY: The study presents and assesses the evidence bearing on the supply-siders' claim that an x percent drop in tax rates would cause a much less than x percent drop in tax revenues. It also assesses whether there is a consensus on the importance of marginal tax rates. The study found agreement among researchers of various political persuasions that cuts in the marginal tax rates for the highest-income taxpayers caused little or no loss in tax revenue for the federal government. The main reason for this result was not, as emphasized in the preceding theoretical literature, that people worked harder in response to lower marginal tax rates, but that people avoided taxes much less. That is, the elasticity of tax avoidance with respect to tax rates turned out to be much larger than the elasticity of labor supply. The study found some evidence that a consensus is developing among tax economists about the importance and desirability of keeping marginal tax rates low.

PUBLICATION: D.R. Henderson, "Are We All Supply-Siders Now?" Contemporary Policy Issues, Vol. VII, No. 4, October 1989, pp. 116-128.

THE SUPPLY-SIDE TAX REVENUE EFFECTS OF THE CHILD-CARE TAX

D.R. Henderson, Associate Professor of Administrative Sciences

Sponsor: None

OBJECTIVE: To estimate the revenue offset that results from the increased work caused by the child care tax credit.

SUMMARY: The child care tax credit acts as a strong incentive for married women with children to work. This added work leads to added tax revenues for federal, state, and local governments that offset the federal government's static revenue loss from the tax credit. This study estimates that for low-income families, governments get 26 to 62 cents in additional tax revenue for every $1 the federal government loses through the child care tax credit for working parents. For higher-income families, governments get 38 to 114 cents per dollar lost. In short, at least one quarter and possibly all of the revenue "loss" typically estimated from the child tax-care credit is a phantom loss: it is gained back because more mothers are motivated to work. These results are used to analyze Congressional and Administration proposals to eliminate the tax credit for high-income families, to sever the link between the qualifying for the tax credit and having both husband and wife work, and to subsidize child care centers.

PUBLICATIONS: D.R. Henderson, "The Supply-Side Tax Revenue Effects of the Child Care Tax Credit," Journal of Policy Analysis and Management, Vol. 8, No. 4, Fall 1989, pp. 673-675.

D.R. Henderson, "Child Care Tax Credits: A Supply-Side Success Story," National Center for Policy Analysis Policy Report No. 140, July 1989.

CONFERENCE PRESENTATIONS: D.R. Henderson, "The Supply-Side Tax Revenue Effects of the Child Care Tax Credit: Estimates and Implications for Public Policy," Annual Meetings of the Western Economic Association International, Lake Tahoe, NV, June 18-22, 1989.

D.R. Henderson, "Comment" on papers by Jacob Klerman and by Roberta Barnes, Annual Meetings of the Western Economic Association International, Lake Tahoe, NV, June 18-22, 1989.

AN EMPIRICAL STUDY OF VIEW MATERIALIZATION STRATEGIES

Magdi N. Kamel, Assistant Professor of Administrative Sciences,
Sponsor: NPS Research Council

OBJECTIVE: To empirically compare the performance of view processing strategies under different materialization strategies, and characterize the conditions under which each strategy performs the best.

SUMMARY: In conventional relational database systems, a view is a virtual relation whose definition is stored in the systems catalog. When a user issues a query on the view, the system retrieves the view definition and modifies the query to an equivalent one on the base relations. Recently, several proposals have considered storing some form of the materialized view to eliminate the need to reevaluate the view definition every time it is referenced. In this research we empirically compare different materialization strategies for view processing. The results of this study will provide insight on the performance of view materialization strategies in a practical setting and allow us to characterize the conditions under which each strategy performs the best. The performance of processing strategies is directly related to the performance of real-time applications. In these systems, timed updates regarding environmental information is periodically relayed from sensors. These updates trigger a view which must be executed rapidly to detect a hostile presence.

PUBLICATIONS: Activities during the reporting period included procurement and installation of hardware, development of main modules for the simulation programs, and conducting preliminary tests.

M. N. Kamel, "An Empirical Study of View Materialization Strategies," (In progress).

ANALYSIS OF FINANCIAL MANAGEMENT ISSUES AT THE FLEET LEVEL

L.R. Jones, Professor of Administrative Sciences
K. Euske, Associate Professor of Administrative Sciences
Sponsor: Commander Naval Air Force, U. S. Pacific Fleet
Office of the Comptroller

OBJECTIVE: To analyze budgetary and financial management issues with impact on the AIRPAC type command.

SUMMARY: The outputs of this project are divided into three categories: (a) research on budget analyst training needs, (b) the approach to closure of TYCOM facilities, (c) the impact of changes in PPBS on TYOM-CINCPACFLT-NAVCOMPT /Pentagon resource sponsor interfaces. The project produced an analysis using survey research of budget analyst training requirements, a model of base closure, and an analysis of PPBS changes with emphasis on programming issues and problems.

PUBLICATIONS: J. McCaffery, L.R. Jones, "Budget Analyst Training: An Analysis of Needs in the Navy," draft paper prepared for publication submission to Public Budgeting and Finance, 1989.

SPONSOR PRESENTATIONS: Presentations of research project findings to Comptrollers of COMNAVAIRPAC and COMNAVSURFPAC on May 27, 1989 in San Diego, CA.

THESES DIRECTED: Neal Nelson, LCDR, USN, "Spending to Save: Modeling the Closure of NAS Moffett Field", M.S., June 1989.

David K. Wright, LT, USN, "Analysis of Budget Analyst Training in Type Commands" M.S., June 1989.

CONGRESSIONAL CONTROL OF NAVY BUDGET EXECUTION

L.R. Jones, Professor of Financial Management
Department of Administrative Sciences
Sponsor: Office of the Comptroller, Office of Budgets and Reports (NCB-1) Department of the Navy

OBJECTIVE: To identify, explain and evaluate the increase in Congressional control of Navy budget execution

SUMMARY: This project has focused on the manner in which Congress exerts control over both DoD and DoN budgeting. It has formulated and tested hypotheses to explain the increase in control documented to have occurred since the late 1960's, with emphasis on the 1980's.

THESES DIRECTED: Glenn C. Bixler, MAJ, USMC, "Congressional Control over the Department of Defense Budget," M.S., December 1988.

Robert L. Williams, CDR, USN, "Intent, Impact, and Public Policy Consequences of Congressional Control of Department of the Navy Budget Execution," M.S., December 1988.

Thomas S. Hollinberger, LCDR, USN, "Maintenance and Repair of Naval Shore Facilities: Resources and Readiness," M.S., December 1988.

BUDGETING AND ACCOUNTING AT THE CINCPACFLT LEVEL

J. L. McCaffery, Professor of Administrative Sciences
K.J. Euske, Professor of Administrative Sciences
Sponsor: Comptroller, CINCPACFLT

OBJECTIVE: This is an ongoing project to investigate the resource allocation process in the Department of the Navy taking the CINCPACFLT level claimancy as a focal point.

SUMMARY: This year saw the development of a data base which indicated fruitful lines for future research. Budget training needs were assessed; additional training materials seem warranted in computer analysis and justification writing. Cross-sectional analysis discloses that at the NAVCOMPT level 60% of the annual budget change is pricing adjustment; a multi-year database has been identified for furthur research. Interviews with POM players at CINCPACFLT and in Washington and the Center for Naval Analysis indicate some resource sponsors always fare better than others. A data base has been identified for more systematic research. During the research year, a significant change in the threat situation occurred leading to a major conference on cutback strategies at CINCPACFLT emphasizing vertical cuts. This trend will be tracked in the following year.

PUBLICATIONS: " Strategies for Achieving Budgetary Goals" in Handbook of Public Administration James Perry, Editor.(Jossey-Bass: San Francisco-London pp.290-301) 1989.

"Making the Most of Strategic Planning and Management" in Managing Public Programs J. Cleary and N. Henry, Editors, (Jossey Bass:San Francisco-London) pp 193-210 1989.

CONFERENCE PRESENTATIONS: Budget Training Workshop, First Annual Conference on Public Budgeting and Financial Managment, Section on Budgeting and Financial Management, Washington, DC, Nov.4, 1989.

Budget Skills and Cutback Management, Surfpac Annual Comptrollers Meeting, San Diego, CA, November 30, 1989.

Computer Skills Training, a tutorial and demonstration exercise at the National Conference of the American Society for Public Administration, Miami, FL, April 11, 1989.

Teaching Computer Skills, a presentation for professors of public administration, at the National Conference on Teaching Public Administration, Charlottesville, VA, March 16th, 1989.

THESES DIRECTED: M.J. Streeter, LCDR, USN, "A Perspective of Budget Management in the Ship Construction and Conversion Account," M.S., June, 1989.

R.A. Marks, LT, USN, "Program Budgeting within the Department of the Navy." M.S., June, 1989.

D.K. Wright, LT, USN, "Budget Analyst Training in Navy Type Commands," M.S., June, 1989.

M.J. Weaver, LT, USN, "Budget Formulation: A Guide for the Navy Field Activity Comptroller," M.S., June, 1989.

RESYSTEMIZATION MODELING SUPPORT

A. W. Mcmasters - Professor of Operations Research
and Administrative Sciences,
Department of Administrative Sciences
Sponsor: Navy Fleet Material Support Office

OBJECTIVE: To develop a Wholesale inventory model for the Navy to use to replenish their inventories of repairable items; the objective function of this model should be related to readiness.

SUMMARY: A new inventory model for managing repairables at the Wholesale or Inventory Control Point (ICP) level is needed to determine when to replenish repairable items. This model should have the same objective function as the Wholesale provisioning (or first buy quantity) model developed on this project between 1982 and 1986; namely, the minimization of the aggregate Mean Supply Response Time (MSRT). The intent of this model is to base decisions for replenishment buys and repair inductions into depots upon the Ready-for-Issue (RFI) inventory position (IP). The completion of model development depends on describing the probability distribution of the IP. Work this past year examined the influences of the model parameters on that distribution through the use of computer simulations. In addition, since a consumable item can be viewed as a limiting case of a repairable item and since such items are also managed at the Wholesale level, an MSRT model was developed consumable items and evaluated with actual item for data against the current consumables model used by the ICPs. The MSRT model was found to be superior for the major measures of effectiveness used by the ICPs.

CONFERENCE PRESENTATIONS: A. McMasters, "A New Replenishment Model for the Wholesale Level in the U. S. Navy," SOLE/NPS 7th Annual Logistics Symposium, Monterey, CA, 13 May 1989.

THESES DIRECTED: R. E. Boike, LCDR, SC, USN and T. H. Stringer, LCDR, SC, USN, "An Evaluation of the Proposed MSRT Replenishment Model for Wholesale Consumable Items," M.S., December 1989.

M. D. Dexter, LT, USN, "Initial Research on an Inventory Control Process for Low Attrition Repairable Items," M.S., December 1989.

STOCK POINT EXPERT SYSTEMS

A. W. McMasters, Professor of Operations Research
and Administrative Sciences,
Department of Administrative Sciences
Sponsor: Naval Supply Systems Command

OBJECTIVE: To develop expert systems to facilitate the decision making of inventory managers at Navy Stock Points.

SUMMARY: For the past four years, NPS has been developing expert systems to aid the inventory manager at Navy Stock Points. Systems for deciding how to handle overdue orders from the Defense Logistics Agency (Delinquent Dues) and determining the causes of inventory errors (Causative Research) have been developed. This year the effort concentrated on the managing of hazardous materials. At present, such items are stored and managed on strictly an intuitive basis. However, the danger in this approach is that two materials may be stored together which are dangerous (i.e., will cause an explosion) when combined. A major need is for a warehouse person to be able to distinguish the nature of an item's hazard by knowing its Navy stock number and then be able to immediately decide where to store a shipment received from a supplier. Such a system is in the final stages of development.

ARMY RESERVE MIGRATION PROJECT

Stephen L. Mehay, Professor of Economics
Sponsor: U.S. Army Recruiting Command,
Program Analysis and Evaluation Directorate

OBJECTIVE: This project has four objecives: (1) to profile the pattern of internal geographic transfers within the US Army Reserve; (b) to compare pattern of internal transfers with that of the civilian labor force; (c) to estimate structural models of migration by Army Reservists; (d) to integrate this information into USARC mission and decision making models.

SUMMARY: We have created longitudinal files of all transactions of Army reservists between 1981 and 1987. The files have been analyzed using multivariate statistical techniques.

PUBLICATION: S.L. Mehay, "Army Reserve Internal Migration: Issues and Analysis," in progress.

THESIS DIRECTED: J. Northcut, LT, USN, "Migration of Army Reserve Members," Master's Thesis, December 1988.

ARMY RECRUITING IN THE 21ST CENTURY

Stephen L. Mehay, Economics Sciences
Mark E. Eitelberg, Associate Professor of Administrative Sciences
Sponsor: U.S. Army Recruiting Command
Program Analysis and Evaluation Directorate

OBJECTIVE: To provide an overview of the future environment in which Army recruiting will be conducted in the 1990s and beyond. The project involves an extensive review of the literature and available projections of future trends in social, demographic, labor force, economic, social, geopolitical and other trends. These trends will be evaluated quantitatively for their impact on Army recruiting requirements and markets.

SUMMARY: The project has started the initial stages of the literature review.

CONFERENCE PRESENTATION: One of the objectives of the project is to organize a conference in late 1990 or early 1991 on the topic of recruiting in the 21st Century and to bring together experts from numerous fields.

SOFTWARE FOR U.S. ARMY TOE RESILIENCY SCREENING

T. P. Moore - Assistant Professor of Management Science,
Department of Administrative Sciences
Sponsor: U.S. Army Combat Developments Experimentation Center

OBJECTIVE: This is a continuing project to implement a screening procedure that can be used by Army force structure designers to perform rapid, low cost initial evaluations of the resiliency inherent in specific Table of Organization and Equipment (TOE) designs.

SUMMARY: A simple screening procedure was developed for proposed Army force structures. The procedure requires information about the number and type of occupational specialties and major equipment in the unit. It produces an estimate of the inherent resiliency in the TOE design.

The procedure needs further testing and refinement to determine the extent of its usefulness to the Army.

PUBLICATIONS: T.P. Moore, "An Investigation of the Use of Resiliency Analysis by U.S. Army Force Structure Designers," Naval Postgraduate School Technical Report, in preparation.

ESTIMATING AND EXPLAINING THE COST OF HIGH-TECHNOLOGY SYSTEMS

O. D. Moses, Associate Professor of Administrative Sciences
Sponsor: Naval Sea Systems Command,
Cost Estimating and Analysis Division

OBJECTIVE: Investigate methods for measuring the extension in technology of new state-of-the-art systems and analyze relationships between technology and cost.

SUMMARY: This project refined methods for measuring extensions in the state-of-the-art of technology in systems by identifying attributes of high-technology systems, combining the attributes into summary measures of the amount of technology in a system and comparing the amount of technology across systems over time to measure technology extensions. Measures of both development and production costs were then estimated using models reflecting system technology. Cost variances (differences between estimated and actual costs) were isolated and economic, financial and environmental factors that explained the cost variances were identified.

PUBLICATIONS: O. D. Moses, "Estimating and Controlling the Cost of Extending Technology: A Revision and Extension," Naval Postgraduate School Technical Report No. 54-89-06, March 1989.

O. D. Moses, "Estimating and Explaining the Cost at High-Technology Systems: The Case of Military Aircraft," Naval Postgraduate School Technical Report No. 54-89-07, May 1989.

CONFERENCE PRESENTATION: O. D. Moses and W. R. Greer, "Estimating and Controlling the Cost of Extending Technology," Annual meeting of the Institute for Cost Analysis, Washington, DC, July 5-7, 1989.

THESES DIRECTED: R. E. Lowe, LCDR, USN, "Estimating the Relationship Between the State of the Art of Technology and Production Cost for U.S. Aircraft," Master's Thesis, June 1989.

J. S. Hicky, LCDR, USN, "Financial Condition of Government Contractors and Control of Production Costs in the Procurement of Major DoD Aircraft Weapon Systems," Master's Thesis, June 1989.

J. C. Scorby, LT, USN, "The Extension of Technology and the Control of Production Costs in Advanced Satellite Systems," Master's Thesis, June 1989.

SOFTWARE PRODUCTIVITY ENHANCEMENT STUDY

Norman F. Schneidewind, Professor of Computer Science
Tarek Abdel-Hamid, Assistant Professor of Information Systems
Department of Administrative Sciences
Sponsor: Navy Management Systems Office (NAVMASSO)

OBJECTIVE: Improve the quality of NAVMASSO's software development and maintenance.

SUMMARY: Developed a validation procedure for software quality metrics. Developed a model of software maintenance and an example of applying the model based on the problem of maintaining local area network software. (Prof. Schneidewind)

Validated software quality metrics are metrics which have a specified quantitative relationship with software quality requirements. In most applications of software quality metrics, the metrics are applied without assurance that the metrics are valid. Either the user assumes the metrics are valid, when in fact the metrics have not been validated, or the user is ignorant of the need to validate metrics before using them. No general procedure or model exists for validating software metrics. This research developed such a model. The research drew heavily on the work of the IEEE Standard for Software Quality Metrics Working Group, which Professor Schneidewind chairs.

An integrated system dynamic simulation model of software project management was applied to the NAVMASSO/SNAP environment

The model can be used by software project managers as a tool to support the project management process. For example, the model supports project staffing, scheduling and software quality assurance management.

PUBLICATIONS: N.F. Schneidewind, "Software Maintenance: The Need for Standardization", Proceedings of the IEEE, Vol.77, No.4, April 1989, pp. 618-624.

Norman Schneidewind, Editor, IEEE Standard for a Software Quality Metrics Methodology (Draft), P1061/D20, September 1989.

Norman F. Schneidewind, "How a Standardized Change Management Methodology Can Improve Software Maintenance", NPS Technical Report, NPS-54-89-09, May 1989.

N.F.Schneidewind, "Software Maintenance: The Need for Standardization", NPS Technical Report, NPS-54-89-02,February 1989.

Tarek K. Abdel Hamid and Stuart E. Madnick, "Lessons Learned from Modeling the Dynamics of Software Development", Communications of the ACM, Vol.32, No. 12, December 1989, pp. 1426-1438.

T.K. Abdel-Hamid, "The Dynamics of Software Project Staffing: A System Dynamics Based Simulation Approach", IEEE Transactions on Software Engineering, (February 1989), pp. 109-119.

Tarek K. Abdel-Hamid, "Modeling the Dynamics of Software Project Management:A System Dynamic Perspective", Tarek K. Abdel-Hamid, Naval Postgraduate School Technical Report, February 1989

CONFERENCE PRESENTATION: Norman F. Schneidewind, Plenary Session Address: "Software Maintenance: The Need for Standardization", Conference on Software Maintenance, Miami, FL, October 19, 1989.

SOFTWARE QUALITY METRICS

Norman F. Schneidewind, Professor of Computer Science,
Department of Administrative Sciences
Sponsor: IEEE Computer Society Standards Activity Board

OBJECTIVE: Develop a standard for software quality metrics.

SUMMARY: As Chairman of the IEEE Software Quality Metrics Working Group, held meetings in San Francisco and at the Naval Postgraduate School for the purpose of developing the standard.

PUBLICATION: Norman Schneidewind, Editor, IEEE Standard for a Software Quality Metrics Methodology (Draft), P1061/D20, September 1989.

DISTRIBUTED SYSTEM SOFTWARE DESIGN PARADIGM AND INTERNETWORKING

Norman F. Schneidewind, Professor of Computer Science,
Department of Administrative Sciences
Sponsor: None

OBJECTIVE: Develop a distributed system software design paradigm.

SUMMARY: The paradigm was developed.

PUBLICATION: Norman F. Schneidewind, "Distributed System Software Design Paradigm with Application to Computer Networks," IEEE Transactions on Software Engineering, Vol. 15, No. 4, April 1989, pp. 402-412.

CONFERENCE PRESENTATION: Norman F. Schneidewind, "Overview of NPS Network Research," Defense Message System R&D Working Group, FNOC, March 28, 1989

ANALYSIS OF FIELD AGENTS WRITTEN COMMUNICATION SKILLS

J.E. Suchan, Associate Professor of Managerial Communication,
Department of Administrative Sciences
Sponsor: Defense Personnel Security Research and Education Center

OBJECTIVE: Determine the current organizational and stylistic characteristics of field agents reports of investigation (ROIs) and empirically assess whether ROIs written in a "high impact" style result in faster adjudicator reading speed, better message comprehension, better decision quality, and increased perception of information completeness than current ROIs.

SUMMARY: Field research determined that DIS field agents wrote ROIs that were poor in document design, organization, and syntactic structure. Furthermore, field agents were largely unaware of the information processing needs of adjudicators when preparing ROIs. Adjudicators complained of eye strain and fatigue largely because of the design, organization, and structure of the ROIs. A research instrument has been developed to determine differences in reading speed, comprehension, adjudication decision quality, perception of information completeness, and confidence in decision quality between ROIs written in a "high-impact" style and the current style. Future work entails gathering empirical data about these dependents variables from adjudicators working in a laboratory setting.

PUBLICATIONS: J.E. Suchan, "Investigative Report Writing: A Field Study," Defense Personnel Security Research and Educational Center, PERS-TR-90-006, December 1989, 32 pages.

CONFERENCE PRESENTATION: J.E. Suchan, "The Written Communication Habits of Public Sector Professionals: A Case Study," The Association for Business Communication International Conference, Las Vegas, NV, November 9-13, 1989.

USAR NURSE RETENTION/ATTRITION STUDY

G. W. Thomas, - Associate Professor of Economics
B. J. Roberts, Adjunct Professor of Administrative Sciences
T. P. Moore, Assistant Professor of Management Science
K. Kocher - Labor Economist, Administrative Sciences Department
Sponsor: U S Army Recruiting Command

OBJECTIVE: Provide insights into retention behavior for the Army Nurse Corps.

SUMMARY: The shortage of nurses in the military has approached crisis dimensions. We developed a comprehensive annotated bibliography, established baseline profiles of active duty and Reserve nurses, and estimated turnover models for nurses. Threshold theory was to develop turnover models and estimates using logit regression with demographic, military background, economic incentive and cognitive/perceptual variables. Results indicate that satisfaction with identified facets of the work environment, with advancement opportunities, and with location stability have significant effects on retention. The effects of race-ethnic group, family status, tenure, and age at service entry were also estimated. Implication for management policies to reduce nurse turn-over were derived.

PUBLICATIONS: B. J. Roberts and K. Kocher, "Recruiting and Retaining Army Nurses: An Annotated Bibliography," NPS Technical Report No. NPS-54-88-015, December 1988, Monterey, CA.

G. W. Thomas, K. Kocher, T. P. Moore and B. J. Roberts, "1987 U.S. Army Nurse Membership, Accession and Loss Profiles:Volume I, Reserves," NPS Technical Report No. NPS-54-88-018, December 1988, Monterey, CA.

G. W. Thomas, K. Kocher, B. J. Roberts, "1987 U.S. Army Nurse Membership, Accession and Loss Profiles: Volume II, Active Duty," NPS Technical Report No. NPS-54-89-10, June 1989.

THESIS DIRECTED: R. P. Franco, LTJG, USN, "An Analysis of the Determinants of Navy Medical Officer Retention," Master's Thesis, December 1989.

USAR ENLISTMENT MOTIVATIONS

G.W. Thomas, Associate Professor of Economics
L.G. Gorman, Adjunct Professor of Economics
Sponsor: U S Army Recruiting Command

OBJECTIVE: The purpose of this study was to analyze the enlistment motivations of high quality enlistees to the US Army Reserves.

SUMMARY: Hierarchical log-linear analysis was used to analyze the responses of Reserve enlistees in the Army's New Recruit Survey. The relationship of various enlistment motivations and the mental group quality of respondents was studied. Specific motivations were identified that can be used by Recruit Command to target the high quality enlistment market.

PUBLICATIONS: L. Gorman and G. W. Thomas, "An Analysis of Enlistment Motivations for United States Army Reserve Recruits," NPS Technical Report No. NPS-54-90-003, November 1989, Monterey, CA.

K. Kocher and G. Thomas, "The Reserve Intentions of Active Duty Army Nurses," NPS Technical Report, NPS-54-88-014, December 1988.

THESES DIRECTED: D. D. Halverson, CPT, USA, "Enlistment Motivators for High Quality Recruits in the Army Reserve," Master's Thesis, June 1989.

L.N. Edwards, LT, USN, "Effects of Marital Dependency Status on Reenlistment Behavior of Second-Termn Enlisted Females," M.S., December 1989.

J.S. Randall, CPT, USMC, "Factors Influencing the Retention of Noncommissioned and Staff Non-Commissioned Officers in Selected Marine Corps Reserve," M.S., December 1989.

MARKET ANALYSIS FOR THE YEAR 2000

G. W. Thomas, Associate Professor of Economics
L. M. Solnick, Associate Professor of Economics
L.G. Gorman, Adjunct Professor of Economics
L. Johnson, Assistant Professor of Operations Research
Sponsor: U S Army Recruit Command

OBJECTIVES: This study had three objectives. First, to derive nation-wide measures of qualified military available and interested (QMA&I) in the U S Army Reserves. Second, to explore the feasibility of using a single family of probability distributions to describe the commute behavior of Reservists to their drill site. Third, to estimate measures of local market competition for the Reserves.

SUMMARY: Objective one was met with pathbreaking analysis of QMA&I at both the county and Zipcode level for the nation. These are the first nationwide measures of interest in joining the military at the local level. The results have been incorporated into the sponsor's recruit marketing and allocation models. Objective two was met with a successful feasibility study. A follow-on expanded study with Professor Johnson as principal investigator will be undertaken in FY90. Objective three resulted in preliminary estimates of local competition for entry level hiring for the Reserves. A follow-on expanded study will be undertaken in FY90 with Professor D. Barr, of Mathematics as the principal investigator.

PUBLICATIONS: G. W. Thomas, "Preliminary Estimates of Qualified Military Available and Interested," Proceedings of the 1989 Recruiting Research Coordination Conference, U.S. Army Recruiting Command, November 1989, Fort Sheridan, IL.

G. Thomas, "Estimates of Qualified Military Available and Interested," U.S. Army Recruiting Command Technical Report, Forthcoming, Fort Sheridan, IL.

CONFERENCE PRESENTATION: G. W. Thomas, "Preliminary Estimates of Qualified Military and Interested," Recruiting Research Coordination Conference, U S Army Recruit Command, Skokie, IL, November 1989.

ESTIMATION OF QUALIFIED MILITARY AVAILABLE POPULATION INTERESTED IN ACTIVE ENLISTMENT FOR YEAR 2010

G. W. Thomas, Associate Professor of Economics
L.G. Gorman, Adjunct Professor of Economics
Sponsor: U S Army Recruiting Command

OBJECTIVE: The objective of this research is to develop second generation estimates of qualified military available and interested in active Army enlistment for the year 2010.

SUMMARY: This is a continuation study in our USAREC research program. The analytical work of previous NPS studies will be used as a foundation for local region estimates of qualified military available population interested in enlisting in the Active Army in the years 1990, 1995, 2000, and 2010.

ESTIMATION OF USN QUALIFIED MILITARY AVAILABLE AND INTERESTED

G.W. Thomas, Associate Professor of Economics
L.G. Gorman, Adjunct Professor of Economics
LT. K. Steiner, USN, Instructor, Administrative Sciences Department
Sponsor: Office of Naval Research, Naval Recruit Command

OBJECTIVES: The objectives of this research are two-fold. First, to validate current Navy Recruit Command (CNRC) estimates of qualified military available (QMA) using methodologies recently developed at the Naval Postgraduate School. Second, to provide first generation estimates of regional variation in interest in enlistment in the Navy.

SUMMARY: Efficient and effective recruiting resource allocation decisions require current and future market information on the geographic distribution of qualified military available and interested (QMA&I). More accurate projections of QMA and first generation estimates of Navy QMA&I will enable CNRC to improve systems for assigning recruiting goals to its subordinate units and making current and future resource allocations. The work will culminate in an assessment of current CNRC QMA estimates, a specific plan for improving those estimates (including identification of data bases and estimation techniques) and first generation estimates of Navy enlistment propensity at the regional level.

BEHAVIORAL/ATTITUDINAL SURVEYS OF CIVILIAN PERSONNEL DEPARTMENT AND OF ENGINEERS AT THE NAVAL AVIONICS CENTER

K.W. Thomas, Professor of Management
B.J. Roberts - Associate Profeesor of Management
Sponsor: Naval Avionics Center

OBJECTIVE: To measure key behavioral/ attitudinal factors influencing the effectiveness of the Civilian Personnel Dept. (CPD) and of Engineering units at the Naval Avionics Center (NAC).

SUMMARY: In Phase I, a survey questionnaire was designed and administered to CPD employees to provide an internal Organi-zational Effectiveness audit of the CPD following a recent reorganization. In Phase II, a second survey questionnaire was designed and administered to a sample of Engineers at NAC to measure factors which may influence key career decisions, including turnover. Portions of the Phase II data have been analyzed for a student thesis (see below). More complete analyses will be performed for technical reports to be completed this year. More Phase II studies, including studies of the effects of leadership upon performance, are also scheduled for this year.

THESIS DIRECTED: T.E. Lindner, LCDR, USN and M.E. Davis, LT, USN, "A Comparative Analysis of Factors Affecting the Career Orientation of Naval Officers and Federal Civilian Engineers," Masters Thesis, December, 1989.

NEAR-OPTIMAL TRANSFER LOTS FOR JOB SHOPS WITH SEVERAL DEPARTMENTS

Dan Trietsch - Associate Professor of Operations Management and
Logistics, Department of Administrative Sciences
Sponsor: NPS Research Council

OBJECTIVE: Investigate methods for determining efficient transfer lots in a job shop environment with several departments, or flow shop environment with several machines in line.

SUMMARY: In a typical job shop, e.g., a Naval Aviation Depot, we have several machines (or departments) and jobs move from one machine to the next as per a sequence which may be unique for each job. A typical job may be a batch of parts, and the traditional standard operating procedure was to move the batch from one machine (or department) to the next as one unit. While this procedure saves money in materials handling costs and is simple to manage, it is also the cause of excessive lead time, costly work in process inventory and poor throughput. Modern leading-edge practitioners and scholars advocate much smaller transfer lots--typically breaking down a batch to several equal transfer lots. However, these transfer lots maintain their size across all machines regardless of transfer costs. The main objective of this research was to investigate methods to specify variable sized lots to minimize the makespan (i.e., the lead time) of a batch subject to a transfer cost budget. For that purpose, a set of fast heuristics was developed. These heuristics are capable of solving the lot sizing problem to near-optimality in polynomial time (i.e., their complexity is low enough to make them applicable to large problems).

PUBLICATIONS: Dan Trietsch, "Optimal Transfer Lots for Batch Manufacturing: A basic Case and Extensions," Technical Report NPS-54-87-010.

Dan Trietsch, "Polynomial Transfer Lot Sizing Techniques for Batch Processing on Consecutive Machines," Technical Report NPS-54-89-011.

CONFERENCE PRESENTATIONS: Dan Trietsch, "Decomposing the Problem of Transfer Lot Sizing for Batch Processing on Consecutive Machines," CORS/TIMS/ORSA Conference at Vancouver, May 8-10, 1989.

THESIS DIRECTED: Richard V. Stauffer, Jr., 1st Lt, USMC, "Automated Production Control System at Depot Maintenance Activity, MCLB, Albany, Georgia," Master of Science in Management Thesis, June 1989.

PRIORITIZING SETUP REDUCTION EFFORTS IN NAVAL SHIPYARDS

Dan Trietsch , Associate Professor of Operations Management and
Logistics, Department of Administrative Sciences
Sponsor: NAVSEA

OBJECTIVE: To prioritize setup reduction efforts in naval maintenance facilites, such as shipyards.

SUMMARY: In a typical job shop, such as those found in naval shipyards, we have several machines (or departments) and jobs move from one machine to the next as per a sequence which may be unique for each job. Since each job may be different, setups are generally required between jobs. These setups can be very time consuming. In order to utilize the setups fully, a high inventory policy is usually pursued whereby most jobs are large batches of identical parts. This results in long lead-times, as well as high finished-goods and work-in-process inventories. Basically there are (at least) two (not mutually exclusive) ways to control the damage associated with lengthy setups. One way is to specify small transfer lots, whereby some items of a batch are moved from one machine to the next before the whole batch is finished. This has been the research subject of this investigator in FY89 (see former page). The second way--espoused by "Japan, Inc."--is to reduce the setups substantially, and thus make possible smaller batches to begin with. Typically, setups which used to take hours were reduced to a few minutes. In this research we will investigate criteria to determine how to allocate setup reduction resources (efforts and dollars) to the various machines so as to maximize the utility to the system.

STRATEGIC MANAGEMENT FOR THE DEFENSE DEPARTMENT

J. J. Tritten, Associate Professor of Strategic Planning, Department of National Security Affairs;
Nancy Roberts, Associate Professor of Strategic Management, Department of Administrative Sciences;
D. Whitt, Associate Professor, Defense Resources Management Center.
Sponsors: Director of Net Assessment (OSD/NA), OSD/Competitive Strategies Office,
Office of the Under Secretary of Defense - Acquisitions/Directorate for Program Integration,
Strategic Planning Branch, and Director of Defense Policy, National Security Council Staff

OBJECTIVE: This project is designed to conduct historical and current research and analysis in the area of strategic management for the DoD. This research will examine two separate areas: first, strategic planning with the goal to define DoD philosophy and mission, establish long- and short-range objectives for the DoD, and select strategies to be used in achieving those objectives; and second, strategic implementation with the goal to develop an organizational strategy, create functional activities necessary to support the strategy, and design control systems to monitor the effectiveness of the strategy in achieving DoD objectives. Multi-year project.

SUMMARY: The investigators have researched the subject area by visiting businesses and government agencies that have strategic planning staffs and programs, interviewing civilian and military personnel connected with the varying aspects of strategic management within DoD, and sought the cooperation of industrial leaders in the project. They have revised two courses in strategic planning and strategic management for the National Security and Administrative Sciences Departments and routinely offer these revised courses. They have developed initial historical cases for use in these courses; e.g. one on the Maritime Strategy and another on Hyman Rickover as an example of a public sector entrepreneur.

PUBLICATIONS: J. J. Tritten and N.C. Roberts, "Strategic Management or Strategic Planning for Defense?" NPS-56-89-002, February 1989, 34 p.

D.G. Wegman, "Net Technical Assessment" NPS-56-89-008, March 1989, 47 p.

R.T. Bradley and N.C. Roberts, "Network Structure From Relational Data: Measurement and Inference in Four Operational Models," Social Networks, Vol. 11, No. 2, 1989, p. 89-134.

N.C. Roberts and P.J. King, "The Process of Public Policy Innovation," Research on the Management of Innovation, Andrew Van de Ven, Harold L. Angle, and Marshall Poole, Eds., New York, New York: Harper & Row, 1989, p. 303-335.

R.T. Bradley and N.C. Roberts, "Relational Dynamics of Charismatic Organization: The Complementarity of Love and Power," World Futures, 1989, Vol. 27, p. 1-37.

J.M. Kenny, "The Dibb Report: Three Years After," NPS-56-89-016, August 1989, 70 p.

CONFERENCE PRESENTATIONS: N.C. Roberts and P.J. King, Stakeholder Discussion Group: A Forum for the Crafting of Public Policy. North American Conference on Peacemaking and Conflict Resolution, Montreal, February 27-March 5, 1989.

N.C. Roberts and P.J. King, "Public Entrepreneurhip: A Typology," Academy of Management, Washington, D.C., August 1989.

N.C. Roberts, "Strategy-Making Process," Joint Staff (J-5) Strategy Division, Washington, D.C., Aug. 89.

THESES DIRECTED: R.D. Kropp, LT, USN, "JCS Planning: Assessment and Recommendations," M.S., September 1989.

N.L. Tanner, LT, USN, and N.K.S. Young-Aranita, LT, USN, "Naval Postgraduate School: An Organizational Assessment," M.S., Sept. 1989.

M.C. Vitale, LCDR, USN, "Analysis of the Competitive Strategies Methodology," December 1989.

M.J. Leahey, MAJ, USMC, "History of Defense Reform From 1979-1989," M.S., December 1989.

W.S. Jesson CPT, USMC, and T.L. Hilliker, MAJ, USMC, "Strategic Management in the Marine Corps," M.S., December 1989.

D.J. Wilson, CDR, USN, "Defense Policy Management Program: A Feasibility Study," M.S., December 1989.

R.K. Knapper, CAPT, USMC, "The United States Marine Corps Information Blockage A Case Study," M.S., December 1989.

APPLYING ANALYTICAL HIERARCHIES TO COMPUTER-FAMILY SELECTION PROCEDURE

Moshe Zviran, Assistant Professor of Information Systems
Sponsor: NPS Research Council

OBJECTIVE: To apply the Multiple Criteria Analysis (MCA) method to the computer family selection procedure and establish a comprehensive methodology for this process.

SUMMARY: An intensive survey on the methodologies in selecting computer hardware was completed, indicating that most current selection models have one feature in common - they address the issue of acquiring a specific system, but fail to address the problem of the need to select a whole family of computer systems. This project suggests the utilization of Saaty's Multiple Criteria Analysis (MCA) method in the procedure of selecting a computer-family.

PUBLICATION: A working paper, entitled: "Applying Analytical Hierarchies to Computer-Family Selection Procedure" is currently in progress.

THESIS DIRECTED: E.S. Davis, LCDR, NOAA,"Developing a Comprehensive Methodology for Computer-Family Selection Procedure", M.S., September 1989.

EVALUATION OF USER AUTHENTICATION TECHNIQUES AS INFORMATION SYSTEMS SECURITY MECHANISMS

Moshe Zviran, Assistant Professor of Information Systems
Sponsor: NPS Research Council

OBJECTIVES: This research has two objectives:
a. To identify the characteristics of user-generated passwords, their feasibility, advantages and disadvantages in providing effective access control.
b. To examine the characteristics of alternative password methods.

SUMMARY: Access control based on verification of a person's identity is a commonly used method in computer installations. The most popular method is to provide authorized users with passwords, which will serve as the "key" for authorized use of the computer system and/or various application systems and try to make unauthorized access virtually impossible. Nevertheless, memorability and safety pose a difficult trade-off in the generation of passwords. If passwords are chosen to make them hard to guess, they may also be hard to remember. A partial list of methods suggested to overcome this trade-off includes cognitive passwords, associative passwords and passphrases. However, no clear solution to the above mentioned trade-off have yet emerged. The suggested research is empirical and aims at evaluating the characteristics of the various authentication techniques.

DEPARTMENT OF COMPUTER SCIENCE

Department of Computer Science Research Summary

Research in the Department of Computer Science is carried out by faculty, research professionals, and by students at both the M.S. and Ph.D. levels. All funded research is conducted under the supervision of a faculty member serving as principal investigator. The research activities of the department can be grouped into four broad areas corresponding to the specialization tracks of our curriculum. A summary of activities in each of these areas follows. When individual faculty members are cited, it is to be understood that the work described also involves research carried out by students and staff under the supervision of the faculty member.

1.0 Military Database Systems

Professor Lum investigated solutions for the different issues in the management of multimedia data; i.e. text, images, sound and graphics. The focus of the current efforts is the integration of natural language descriptions with the various contents of the database. Additional work was performed on developing the best data model for the multimedia database problem. Professor Hsiao performed work in both database systems and in database security. His work includes database system support for the software engineering environment, applications of the multimodel, multilingual and multibackend database system, architectures for real-time database access, and effective access control and efficient database security. Professor Wu continued work on the design and development of a multimedia database system in support of the paperless ship (Argos System). Part of Professor Wu's work was to investigate the effectiveness of using an object-oriented approach in developing the Argos System. Professor Wu also worked on developing a visual interface to a backend database system capable of supporting both data definition and data manipulation languages.

2.0 Software Engineering

Professor Berzins investigated the development of fundamental theory and practical methods for combining several changes to a software system with mathematically provable guarantees of correctness. His work has important potential applications to software maintenance, view integration in specifications, version control in design databases, and multiple inheritance in specification or programming languages. Professor Luqi investigated the development of new technologies for the computer-aided design of Ada software systems. This work includes the development of a set of software tools for validating requirements and formalizing design efforts for Ada software systems. Professor Luqi's work also is aimed at developing an automated rapid prototyping environment for practically validating the requirements, specifications, and design of large and embedded software systems. Besides the above two efforts, Professor Luqi also has ongoing projects in iterative prototyping for evolutionary software development and execution support of a computer-aided prototyping system for real-time systems. Professor Shimeall is investigating the refinement of software testing theories through the development of tools for studying the failure behavior of software. His work includes the development of a method for analyzing software to determine the set of inputs that generate program failures.

3.0 Tactical Computer Systems

Professor Kodres continued his work on real-time prototyping on a multiple transputer system. This project is exploring the use of a single chip computer, the transputer, as a component of a larger multicomputer network. Professor Kodres' work includes the design of software and hardware for making such a network reliable as well as fault tolerant. Professor Lundy performed work on the formal modeling of local area networks. His work includes the development of a clear, precise, and formal specification of several major local area network protocols; i.e. the IEEE standard protocols and several military protocols. Professor Zaky investigated efficient, fine-grained scheduling of recurrence loops. The focus of this work is on extending current methodologies for the efficient execution of recurrence loops on Very Long Instruction Word (VLIW) architectures.

4.0 Artificial Intelligence and Robotics

Professor McGhee investigated basic technologies relating to the real-time control, artificial intelligence, and computer architectures needed for the support of autonomous underwater vehicles. He also investigated the use of terrain data from an optical radar system to automatically determine suitable footholds for a hexapod walking machine. Professor McGhee also continued work on the development of a prototype mobility expert system for land locomotion. The mobility expert system is to serve as a decision aid for USATEC in support of its military systems testing mission at Fort Hunter-Liggett, California. Professor Rowe performed work on the computer planning of missile paths using discrete optics analogs. In that work, he investigated algorithms for finding energy-minimizing and concealment-maximizing paths above highly contoured terrain for simple models of cruise missiles. Professor Zyda continued his work on the development of real-time techniques useful for the development of inexpensive, three-dimensional visual simulators. There are two main projects in this work, a Navy project and an Army project. For the Navy, Professor Zyda is conducting exploratory work on utilizing three-dimensional displays for Command and Control Workstations of the Future (CCWF). For the Army, Professor Zyda is conducting work on producing a low-cost three-dimensional visual simulator for the land locomotion and low-flight environments. Professor Zyda's work includes real-time intervisibility computations, high-resolution terrain database displays, parallel processing algorithms, autonomous simulated vehicles and networked, multiple workstation simulations. Professor Shing investigated efficient algorithms for finding optimal paths and layouts. His research includes work on an asynchronous parallel procedure for the weighted region, shortest path problem (WRSP) using transputers, a good approximate algorithm for the WRSP using simulated annealing, an efficient algorithm for searching through an unknown maze, and efficient algorithms for special cases of rectilinear Steiner trees. Professor Lee worked on developing general algorithms for reasoning about logic programs and their specifications. He also worked on developing a knowledge base of debugging expertise for use with logic programs. His work includes the implementation of a program debugger that can utilize general inference strategies and expert debugging knowledge. In addition to this research, he also worked on real-time control and obstacle avoidance problems relating to the NPS Model 2 Autonomous Underwater Vehicle. Professor Erickson worked on developing algorithms for the node-coloring problem. His work includes the application of these algorithms to the NPS class scheduling problem.

FUNDAMENTAL THEORY FOR AUTOMATICALLY COMBINING CHANGES TO SOFTWARE SYSTEMS

V. Berzins - Professor of Computer Science
Department of Computer Science
Sponsor: Office of Naval Research (Direct Funding)

OBJECTIVE: We seek to develop fundamental theory and practical methods for combining several changes to a software system with mathematically provable guarantees of correctness. Combining changes to software is a fundamental problem in software engineering with widespread applications in the design and maintenance of software systems. This process is important in all phases of developing large software systems, where multiple changes must be developed concurrently and then combined. This work has important potential applications to software maintenance, view integration in specifications, version control in design databases, and multiple inheritance in specification or programming languages.

SUMMARY: The main goal of this research effort is to enable a higher level of computer-aided design in the development of large Ada software systems. We have developed automatable methods and software tools which guarantee some aspects of the software are correct by construction or locate faults in specifications, designs, and programs. The focus of our work has been to explore automated methods for solving the software combination problem. The software combination problem is the task of combining several independent updates to a software system. Most useful software systems evolve as the result of a series of enhancements and repairs which are too extensive to be handled by a single person. Typically, different people are assigned to extend or modify different aspects of a software system concurrently, so that the results of their work must be combined when the job is done. We have extended previous work, which treated compatible extensions to programs, to include incompatible changes. The theoretical basis for this work has involved embedding the approximation lattices used for representing pure extensions into a large boolean algebra, which provides a difference operator on programs.

PUBLICATIONS: V. Berzins, Luqi, "An Introduction to the Specification language Spec," to appear in IEEE Software.

V. Berzins, "Black-Box Specification in Spec," to appear in Computer Languages.

V. Berzins, "Distributed Algorithms for Generating Unique Identifiers," revised for IEEE Transactions on Computers.

V. Berzins, "Integrating Changes to Programs and Specifications," Acta Informatica, in progress.

V. Berzins, R. Kopas, "Specification of a Robust Network," Proceedings of the Hawaii InternationalConference on System Sciences, Jan. 1990.

R. Kopas, V. Berzins, "The Design and Implementation of a Specification Language Type Checker," Proceedings of the Hawaii International Conference on System Sciences, January 1990.

V. Berzins, B. Kopas, "A Student Guide to Spec," Technical Report NPS 52-89-029, Naval Postgraduate School, 1989.

V. Berzins, R. Kopas, "Specification of a Robust Network," Technical Report NPS 52-89-034, Computer Science Department, Naval Postgraduate School, 1989.

V. Berzins, D. Beebe, "User's Manual for the SPECDEF Editor," Technical Report NPS 52-89-041, Computer Science Department, Naval Postgraduate School, 1989.

R. Kopas, V. Berzins, "The Design and Implementation of a Specification Language Type Checker," Technical Report NPS 52-89-045, Naval Postgraduate School, 1989.

CONFERENCE PRESENTATION: V. Berzins, "A Graphical Interface for Computer-Aided Prototyping Systems," Hawaii International Conference on System Sciences, Jan. 3-6, 1989.

THESES DIRECTED: R. Kopas, LTjg, USN, "Generating a Specification Type Checker using a Fourth Generation Language," Master's Thesis, June 1989.

David Beebe, LCDR, USN, "Generating A Syntax-Directed Editor for the Specification Language Spec," Master's Thesis, June 1989.

THE NPS ACADEMIC COURSE SCHEDULER

D.A. Erickson - Adjunct Instructor of Computer Science,
Department of Computer Science
Sponsor: Naval Postgraduate School Research Council

OBJECTIVE: To develop algorithms for the node-coloring problem; to successfully apply these algorithms to the school-scheduling problem; to create a working school scheduling program for use at Naval Postgraduate School.

SUMMARY: During 1989, the school scheduling program (SSP) received the following modifications: a user front-end was written which provides basic interactive support for manual scheduling, and procedures which permit fully automated scheduling (node-coloring) were designed, programmed, and tested. However, the problem remains intractable; excessive CPU time was required by the exhaustive coloration approach. A new approach was designed using the simulated annealing technique (a random, probabilistic method), which has been shown by other investigators to color random graphs near-optimally with less demand on computing resources than competing algorithms.

DATABASE-SYSTEM SUPPORT FOR THE SOFTWAVE ENGINEERING ENVIRONMENT

D.K. Hsiao - Professor of Computer Science
Department of Computer Science
Sponsor: Naval Air Development Center (Direct Funding)

OBJECTIVE: The multimodel and multilingual database system makes many data models and data languages available to the engineering of software modules and systems. It may be an ideal system to provide tools and methodologies for the software engineering of data-driven systems.

SUMMARY: The presence of a prototyped multimodel, multilingual and multibackend database system in the NPS Laboratory for Database Systems Research may be used as a test bed or vehicle for constructing software engineering environments (SEEs). The particular SEE is instrumented for the Navy Embedded System Software Efforts.

PUBLICATION: B. Holtkamp, D.K. Hsiao, V.Y. Lum, "Heterogeneous Database Systems: MUSE-Levels of Integration," Proceedings of Heterogeneous Databases Workshop, Chicago, December 1989.

CONFERENCE PRESENTATION: D.K. Hsiao, "Heterogeneous Data-bases: Proliferations, Issues and Solutions," Heterogeneous Databases Workshop, sponsored by National Science Foundation and Northwestern University, Chicago, December 1989.

THESIS DIRECTED: William A. Sheenan, LT, USN, "Accessiting Network Databases via Hierarchical Transactions," M.S., December, 1989.

APPLICATIONS OF THE MULTIMODEL, MULTILINGUAL AND MULTIBACKEND DATABASE SYSTEM

D.K. Hsiao - Professor of Computer Science,
Department of Computer Science
Sponsor: Naval Pacific Missile Test Center

OBJECTIVE: Applications of our research system to high precision text retrieval, heterogeneous database accesses and controls, and multilevel secure databases.

SUMMARY: In its first phase, we plan to transport our research software to NPMTC and "bootstrap" our system onto their hardware, so that we can facilitate their applications of our software.

PUBLICATIONS: James Hall, D.K. Hsiao and M.N. Kamel, "A Parallel and Scalable Architecture for Database Management - The Multibackend Database System," Proceedings of PARBASE - 90, (1990 Conference on Databases, Parallel Architectures and Applications), Forthcoming.

S.A. Demurjian, and D.K. Hsiao, "The Multi-Model Databases System," Proceedings of International Phoenix Conference on Computers and Communications, March 1989.

CONFERENCE PRESENTATION: D.K. Hsiao, "Heterogeneous Databases: Proliferations, Issues and Solutions," International Federation of Information Processing, Working Group 2.6 (Databases), Sweden, June 12-14, 1989.

THESIS DIRECTED: Dennis Walpole, LCR, USN, and Al Woods, LT, USN, "The Design and Implementation of a Relational to Network Interface for Cross-Model Accessing," Master's Thesis, December 1989.

THE ARCHITECTURAL ISSUES OF SEATECS

D.K. Hsiao - Professor of Computer Science,
Department of Computer Science
Sponsor: Naval Ocean Systems Center (Direct Funding)

OBJECTIVE: SEATECS stands for software engineering automation for tactical embedded computer systems. We intend to transfer a multimodel, multilingual and multibackend database system to Naval Ocean Systems Center for supporting the automation.

SUMMARY: The purpose of the transfer of our research software and system to Naval Ocean Systems Center is to examine whether such an advanced database system can serve as an effective and efficient software engineering automation for tactical embedded software development.

PUBLICATIONS: T. Wu and D.K. Hsiao, "Implementing Visual Database Interface By Using An Object-Oriented Language," Proceedings of IFIP WG 2.6 Conference on Visual Database Systems, International Federation of Information Processing Press, (North-Holland), April 1989.

CONFERENCE PRESENTATIONS: T. Wu and D.K. Hsiao, "Implementing Visual Database Interface By Using An Object-Oriented Language," Conference on Visual Database Systems, Tokyo, Japan, April 1989.

THESIS DIRECTED: Darrel W. Alston, CAPT, USA, "On the Instrumentation of a Parallel, Scalable and Expandable Database Computer for Benchmarking," Master's Thesis, December 1989.

EFFECTIVE ACCESS CONTROL AND EFFICIENT SECURITY

D.K. Hsiao - Professor of Computer Science,
Department of Computer Science
Sponsor: Naval Research Laboratory (Direct Funding)

OBJECT: Investigate an effective and efficient algorithm to partition a database of classified information so that the users of different clearance levels can access data they are cleared for without passing through data they are not cleared for.

SUMMARY: The attribute-based data model for conventional databases has been extended to characterize multilevel secure databases. An equivalence relation has been proposed which can partition both the meta data and the base data of a data base into mutually exclusive secure compartments. These compartments incur no pass-through problems. Further, they improve access precision to individual data items, i.e., authorized information.

PUBLICATION: G.S. Hoppenstand, and D.K. Hsiao, " Secure Access Control with High Access Precision: An Efficient Approach to Multilevel Security," Database Security, II - Status and Prospects, (Editor: C.E. Landwehr), North-Holland, 1989.

THESES DIRECTED: Matthew J. Kohler, LT, USN, and Shawn M. Stroud, CAPT, USMC, "An Effective Access Control Mechanism and Multilevel Security for Multilevel Secure Databases," Master's Thesis, December 1989.

Claudia Kiefer, LT, USN, "Computer Network Security Requirements," Master's Thesis, December 1989.

THE REAL-TIME DATABASE COMPUTER

D.K. Hsiao - Professor of Computer Science
M.N. Kamel - Professor of Administrative Science
Department of Computer Science
Sponsor: Naval Ocean Systems Center (Direct Funding)

OBJECTIVE: The main objective is to develop a temporal data model to characterize real-time database management tasks and data bases.

SUMMARY: A survey of temporal data models and languages has been completed and resulted in a Master's Thesis.

PUBLICATION: D.K. Hsiao and M.N. Kamel, "Heterogeneous Databases: Proliferations, Issues and Solutions," IEEE Transactions on Knowledge and Data Engineering, Volume 1, No. 1, 1989.

REAL TIME PROTOTYPING ON A MULTIPLE TRANSPUTER SYSTEM

U.R. Kodres - Professor of Computer Science
Department of Computer Science
Sponsor: Strategic Systems Projects Office (Direct Funding)

OBJECTIVE: This project explores the use of a single chip computer, the transputer, as a component of a larger multicomputer network. The design of software and hardware to make such a network reliable as well as fault tolerant is the main long term objective of this project.

SUMMARY: During this academic year we concentrated on fault tolerance issues. A thesis by W.F. Benage, explored "A Fault Tolerant Software Algorithm for a Network of Transputers." Another thesis by W.P. Pikelis, "Dynamic Reconfiguration and Link Fault tolerance in a Transputer Network," explored the dynamic configuration control by a hardware cross-bar switch. Both of these projects contributed to the development of reliable, fault tolerant systems which are survivable under battle damage conditions. This work should be of value in the construction of robust real-time systems for the future Navy computer architectures.

THESES DIRECTED: W.F. Benage, LT, USN, "A Fault Tolerant Software Algorithm for a Network of Transputers," Master's Thesis, June 1989.

W.P. Pikelis, LT, USN, "Dynamic Reconfiguration and Link Fault Tolerance in a Transputer Network," Master's Thesis, June 1989.

KNOWLEDGE BASED PROGRAM DEBUGGING

Y. Lee - Assistant Professor of Computer Science
Department of Computer Science
Sponsor: Naval Postgraduate School Research Council

OBJECTIVES: To develop general algorithms for reasoning about logic programs and their specifications; to develop a knowledge base of debugging expertise for use with logic programs; to implement a program debugger that can utilize general inference strategies and expert debugging knowledge.

SUMMARY: We explored the use of executable specifications in automating the process of debugging logic programs. We have formulated a computer model that encodes programming knowledge including a classification of program bugs, heuristics that analyze and repair program errors, and operational semantics of the language, and is capable of reasoning with programs and their specifications.

The realization of our methodology is the Constructive Interpreter which functions as a debugger as well as a program synthesizer. It contains three major components: test case generator, bug locator, and bug corrector. The test case generator can generate test data systematically by executing specifications. The bug locator will automatically locate a bug should the program fail to compute an answer that agrees with the specifications. The bug corrector will analyze the nature of the bug and invoke correction heuristics which might involve the use of: 1) a deductive theorem prover which will try to construct a proof and deduce sufficient conditions to amend the program, and (2) an inductive program generator which will synthesize the missing part of the program.

PUBLICATIONS: Y. Lee, "A Knowledge Based Approach to Program Debugging," Technical Report NPS 52-89-060, September 1989.

Y. Lee, "Logical Debugging," in progress (under revision for submission to Journal of Logic Programming).

Luqi and Y. Lee, "Interactive Process of Rapid Prototyping," Broc. of IEEE Thirteenth Annual International Computer Software and Applications Conference, Orlando, Florida, September 1989.

V. Berzins and Y. Lee, "Generating Display for Specifications Based on Attribute Grammar," IEEE Thirteenth Annual International Computer Software and Applications Conference, Orlando, Florida, September 1989.

THESIS DIRECTED: M.H. Wang, LT, Navy, Taiwan, "A Rule-Based System for Shipboard Air Defense," Master's Thesis, December 1989.

MULTIMEDIA DATABASE MANAGEMENT SYSTEM

V.Y. Lum, Professor of Computer Science
N. Rowe, Associate Professor of Computer Science
C.T. Wu, Associate Professor of Computer Science
B. Holtkamp, Adjunct Research Professor of Computer Science
Department of Computer Science
Sponsor: Naval Ocean Systems Command (Direct Funding)

OBJECTIVE: The objective is to investigate and find solutions for the different issues on managing multimedia data like text, images, graphics, sound, etc. that come with advanced applications. The proposed solutions are to be incorporated into a prototype DBMS to demonstrate feasibility.

SUMMARY: A major problem in handling multimedia data is in addressing their contents which are frequently most complex. Automatic extraction by computers is seen to be infeasible for any foreseeable future. It has been proposed that users use natural language to describe the contents of these data and these descriptions are stored with the multimedia data in the computer for processing. The descriptions are transformed by a parser into predicates that can be used by Prolog. These predicates are stored in the system to match with query specifications through Prolog, after the media data content descriptions in the queries are transformed first by the parser into predicates as well. A prototype was implemented to demonstrate the use of Prolog to match the queries to the stored descriptions. Matching predicates with Prolog is a slow process. New data structures have been created that would expedite the processing aspect but retaining the same power of Prolog. It is expected that such kind of structures will be incorporated into the prototype in the future. A major difficulty in the project's proposed approach is that natural language application is too broad. Techniques must be developed to restrict the scope but retain the essential power to allow users to use the language conveniently and describe whatever is appropriate. A study is underway to see how to restrict the natural language specification without sacrificing the power.

Another aspect that makes multimedia data difficult to handle is the complexity in its structure. A multimedia data instance in itself may be composed of many other different multimedia data. To allow for such a possibility, it is necessary to have a more complex data model than is used for traditional data. Research to see what kind of data model most suitable for such a task was initiated.

PUBLICATIONS: K. Meyer-Wegener, V.Y. Lum, and C.T. Wu, "Image Management in a Multimedia Database System," Proceedings of the IFIPS Working Conference on Visual Database Systems, Tokyo, April 1989.

V.Y. Lum and K. Meyer-Wegener, "A Multimedia Database Management System Supporting Contents Search in Media Data," Naval Postgraduate School Technical Report, NPS 52-89-020, March, 1989.

V.Y. Lum and K. Meyer-Wegener, "An Architecture for a Multimedia DBMS Supporting Content Search," submitted to International Conference on Computing and Information, Niagara Falls, Canada.

V.Y. Lum and K. Meyer-Wegener, "A Concept for Multimedia Object Management to Support Content Search," in progress.

CONFERENCE PRESENTATIONS: K. Meyer-Wegener, V.Y. Lum, and C.T. Wu, "Image Management in a Multimedia Database System," presented at the IFIPS Working Conference on Visual Database Systems, Tokyo, April 3-7, 1989.

FORMAL MODELING OF LOCAL AREA NETWORKS

G. M. Lundy - Assistant Professor of Computer Science
Department of Computer Science
Sponsor: Naval Postgraduate School Research Council

OBJECTIVES: To develop a clear, precise and formal specification of several major local area network protocols. This includes the IEEE standard protocols and several military protocols. For each specification, if possible, give a formal analysis of the protocol. The analysis should prove that the protocol is free from deadlocks (if applicable), and other errors and that the desired functions of the protocol are indeed accomplished. These functional properties are referred to as "liveness" in the literature.
To extend the modeling of protocols into the upper layers of computer network protocols.

SUMMARY: During 1989, specifications were developed for three local area network protocols. First, a specification of the Token Ring Protocol was developed, and a limited analysis was also accomplished. The results of this were reported in the SDNC Conference paper (listed in publications).
Second, a specification and analysis was done of the CSMA/CD protocol. The analysis of the protocol was for freedom from deadlocks, nonexecutable transitions, and a limited liveness property. The analysis was given as a proof of two theorems and a corollary. The results were reported in a conference paper (see publications), and a submitted journal paper. Third, a specification and analysis of a military protocol, the MIL-Standard 1553, was developed. This work was submitted to the MILCOM (military communications) conference, to be held in Monterey this year. With respect to upper layer protocols, during 1989, specifications were developed for two data compression protocols, and a third which combined the first two. First, a specification of the Huffman Protocol was developed. A different model for the specification and analysis was used than was done for local area networks. The specification was as a set of communicating processes, connected by FIFO queues. Each process was specified as a set of guarded commands. The analysis was also accomplished. This was done through a proof that an assertion stating the desired property was an invariant -- that is, that once true, the assertion always remains true under the protocol specification. A specification and analysis were also developed for a "zero squashing" protocol, another data compression protocol. This protocol was specified in the same manner, and an invariant was also found and proven.
Finally, the two protocols were combined into a more powerful compression protocol, thus increasing the compression further. The analysis was also given as a proof of a third invariant.

PUBLICATIONS: G. M. Lundy and L. Luqi, "Specification and analysis of a Token Ring Protocol Using Systems of Communicating Machines," Proceedings of Systems Design and Networks Conference, Santa Clara, California, May 23-25, 1989.

G. M. Lundy and Raymond Miller, "Specification and Analysis of a CSMA/CD Protocol Using Systems of Communicating Machines," submitted to the Tenth International Symposium on Protocol Specification, Testing and Verification, 1990.

G. M. Lundy and Raymond E. Miller, "Analyzing a CSMA/CD Protocol through a Systems of Communicating Machines Specification," submitted to IEEE Transactions on Communications.

G. M. Lundy, and Mohamed Gouda, "An Exercise in Protocol Composition: Data Compression," submitted to the Tenth International Symposium on Protocol Specification, Testing and Verification, 1990.

G. M. Lundy and Pete Christensen, "Specification of the MIL-Standard 1553 Protocol," submitted to MILCOM 90 Conference.

THESES DIRECTED: S. Parulian, CPT, Indonesian AF, "A Proposal for a Computer Network for the Indonesian Air Force's Remote Site Radar System," Master's Thesis, March 1989.

N. Ayik, 1st LT, Turkish Army, "An Analysis of the Token Ring Protocol," Master's Thesis, March 1989.

C. Raiche, CPT, USAF, "A Specification and Analysis of the IEEE Token Ring Protocol," Master's Thesis, June 1989.

M. Lofcali, LTjg, Turkish Navy, "A Specification of a CSMA/CD Protocol Using Systems of Communicating Machines," Master's Thesis, June 1989.

J. Kadarma, 1st LT, Indonesian AF, "Specification of a Bridge for Local Area Networks," Master's Thesis, September 1989.

P.H. Christensen, LCDR, USN, "Specification of the MIL-Standard 1553 Protocol Using Systems of Communication Machines," December 1989.

AN AUTOMATED PROTOTYPING ENVIRONMENT

Luqi - Professor of Computer Science
Department of Computer Science
Sponsor: National Science Foundation

OBJECTIVE: Our research is aimed at developing an automated rapid prototyping environment to practically validate the requirements, specification and design of large and embedded software systems. Effectively and efficiently validating requirements is an important unsolved problem in software engineering. We use executable prototypes and Computer-Aided tools for ensuring that the requirements accurately reflect the real needs of the user, increasing reliability and reducing costly requirements changes.

SUMMARY: Formal specifications and conceptual system design models are the fundamental basis for our approach. The proposed environment consists of a prototyping language, a software base, and many other tools. The state of the art research problems we have addressed are developing transformation techniques for the prototyping language and exploring ways to realize a software base with capabilities for retrieving reusable software based on formalized component specifications. Program construction is sped up with mechanical assistance on automated management of software and automated generation of code interconnecting available modules and tasks. After a one-year feasibility study we have successfully built an executable software prototype of an automated prototyping tool set including user interface, run-time support, dynamic and static scheduling, translator generation, software base and management system, project database, graphic editor, etc.

PUBLICATIONS: Luqi, "Rapid Prototyping Languages and Expert Systems," IEEE Expert, pp. 2-5, Summer 1989.

Luqi, "Software Evolution through Rapid Prototyping," IEEE Computer, pp. 13-25, May 1989.

Luqi, Y. Lee, "Interactive Control of Prototyping Process," Proceedings of IEEE COMPSAC 89, Orlando, Florida, September 1989, pp. 447-454.

B. Lundy, Luqi, "Specifications of Token Ring Protocol Using Systems of Communicating Machines," Proceedings of IEEE Conference on Systems Design and Networks, May 1989, pp. 9-16.

Luqi, "Rapid Prototyping Languages for Expert Systems," Technical Report NPS 52-89-032, Naval Postgraduate School, 1989.

Luqi, P. Barnes "Graphical Support for Reducing Information Overload in Rapid Prototyping," Technical Report NPS 52-89-028, Naval Postgraduate School, 1989.

Luqi, Y. Lee, "Interactive Control of Prototyping Process," Technical Report NPS 52-89-025, Naval Postgraduate School, 1989.

B. Lundy, Luqi, "Specifications of Token Ring Protocol Using Systems of Communicating Machines," Technical Report NPS 52-89-024, Naval Postgraduate School, 1989.

Luqi, "Computer Languages for Rapid Prototyping," Technical Report NPS 52-89-023, Naval Postgraduate School, 1989.

B. Douglas, Luqi, "A Design Database for Rapid Prototyping," Technical Report NPS 52-89-022, Naval Postgraduate School, 1989.

CONFERENCE PRESENTATIONS: Luqi, "Computer-Aided Prototyping of Embedded Software Systems," Computer Science Department, University of Minnesota, Minneapolis, Minnesota, March 1989.

Luqi, V. Berzins, "Graphical Tools for a Computer Aided Prototyping System," 22nd Annual Hawaii International Conference on System Sciences, Kailua-Kona, Hawaii, January, 1989.

THESIS DIRECTED: L. White, LT, USN, "The Development of a Rapid Prototyping Environment," Master's Thesis, Dec. 1989.

ITERATIVE PROTOTYPING PROCESSES FOR EVOLUTIONARY SOFTWARE DEVELOPMENT

Luqi - Professor of Computer Science
Department of Computer Science
Sponsor: Naval Ocean Systems Center

OBJECTIVE: The traditional life cycle approach to model the evolution of software systems is criticized for the high cost of revisions and maintenance caused by the sequential ordering of development phases. Rapid Prototyping is an alternative to the life cycle model. The goal of computer aided rapid prototyping is to automate the requirements engineering and design effort at the early phases of software development. The principal idea of rapid prototyping is quickly building and evaluating a series of prototypes, each providing an executable model of selected aspects of a proposed system.

SUMMARY: The goal of this research is to automate the requirements engineering and design effort at the early phases of software development. Software models can be used to demonstrate the technical feasibility of a software idea, and early system tests under concrete environment conditions may supplement analysis and verification results gained from mathematical system models in which such conditions are usually abstracted away.
The result of the project devises a software method that supports iterative software development and allows a high degree of computer support in prototype development and evaluation.

PUBLICATIONS: Luqi, "Models for Evolutionary Software Development," Technical Report NPS 52-89-055, Naval Postgraduate School, 1989.

Luqi, "Multi-Level Software Analysis and Testing in Evolutionary Software Development," Technical Report NPS 52-89-056, Naval Postgraduate School, 1989.

W. Yin, Luqi, M. Tanik, "Rapid Prototyping for Software Evolution," Technical Report NPS 52-89-014, Naval Postgraduate School, 1989.

EXECUTION SUPPORT OF A COMPUTER AIDED PROTOTYPING SYSTEM FOR REAL-TIME SYSTEMS

Luqi - Professor of Computer Science
Department of Computer Science
Sponsor: Office of Naval Research (Direct Funding)

OBJECTIVE: A computer aided rapid prototyping system to support the development of software systems with hard real-time constraints is especially important for the critical early stages of software design. This research focuses on formal techniques for specifying such complex systems using a Prototype System Description Language and the associated tools for further analysis and design. A major goal of this work is to enable the automation of a larger part of hard real-time software development via execution of real-time prototypes. A special scheme is used to treat the hard real-time constraints and to integrate guidelines beyond conventional compiler technology.

SUMMARY: This project studied automated tools for designing and constructing large real-time software systems. Specific subjects that were addressed include: 1. Providing the conceptual design of CAPS tools, e.g., static scheduler, dynamic scheduler, run-time debugging system, etc. 2. The application of CAPS tools to the specification of real-time systems to establish its ability to handle practical problems. 3. Proposing simplifications and extensions to the PSDL language to improve the treatment of hard real-time constraints. 4. Developing execution support tools to handle a subset of the PSDL
language constructs sufficiently rich to illustrate the feasibility of automatic generation of executable prototypes for the specified systems. This research uniquely links the two major research flows on modeling of real-time systems and complexity studies on scheduling algorithms in this research area. The hard real-time computational model used and specification based prototyping language provide systematic and unified constructs for modeling, specifying, designing and testing software systems with hard real-time properties.

PUBLICATIIONS: Luqi, "Handling Timing Constraints in Rapid Prototyping," Proceedings of the 22nd Annual Hawaii International Conference on System Sciences, Kailua-Kona, Hawaii, January, 1989, pp. 417-424.

Luqi, T. Davis, "A Software Prototype of the Message Processor in a Navy C3I Station - Modeling and Specification of Hard Real-Time Systems in PSDL," Technical Report NPS 52-89-015.

CONFERENCE PRESENTATIONS: Luqi, "Handling Timing Constraints in Rapid Prototyping," 22nd Annual Hawaii International Conference on System Sciences, Kailua-Kona, Hawaii, January, 1989.

Luqi, "Rapid Prototyping in Real-Time Systems," 22nd Annual Hawaii International Conference on System Sciences, Panelist in the Minitrack on Hard Real-Time Systems, Kailua-Kona, Hawaii, January 1989.

THESES DIRECTED: H. Guentenburg, LCDR, Navy, Germany, "Automatic Generation of an Aircraft Inertial Navigation System," Master's Thesis, May, 1989.

M. Kilic, LTjg, Navy, Turkey, "Static Schedulers for Embedded and Hard Real-Time Systems," Master's Thesis, December, 1989.

D. Ross, LT, USN, "Object Management in a Combat Direction System," Master's Thesis, December, 1989.

AUTOMATED SOFTWARE TOOLS FOR THE DESIGN OF LARGE ADA SOFTWARE SYSTEMS

Luqi - Professor of Computer Science
B. Kraemer - Professor of Computer Science
V. Berzins - Professor of Computer Science
Department of Computer Science
Sponsor: Office of Naval Research (Direct Funding)

OBJECTIVE: The Software Engineering Laboratory in the Department of Computer Science at the Naval Postgraduate School is developing new technologies for computer-aided design of Ada software systems. A set of software tools for validating requirements and formalizing design efforts of Ada Software Systems are under design and development by applying and extending current state of the art research results in software engineering and in artificial intelligence to automate a larger part of the effort in software development. This project emphasizes the refinement of a formal specification tool set suitable for supporting computer-aided development of large Ada programs. To meet urgent needs of DoD, the primary goals of this work are to improve programmer productivity and the quality, reliability, and flexibility of software systems.

SUMMARY: This project involves the investigation of automated tools for designing and constructing large software systems. Specific subjects addressed by our work include:
1. Generating tools for checking the consistency constraints associated with the formal specification language.
2. Testing language analysis tools through test cases to ensure the correctness of such tools.
3. Building a syntactic checking facility as an initial step towards an intelligent user interface and to serve as a vehicle for further research. 4. Investigating techniques for automatic design completion based on consistency constraints and engineering database support.
5. Incorporating design completion methods into developed tool set to demonstrate the feasibility of such tools.

PUBLICATIONS: V. Berzins, Y. Lee, Luqi, "Generating Displays for Specifications in Spec," Proceedings of IEEE COMPSAC 89, September 1989, pp. 596-602.

I. Mostov, Luqi, "A Graph Model for Software Maintenance," Technical Report NPS 52-89-062, Naval Postgraduate School, 1989.

Luqi, V. Berzins, B. Kraemer, L. White, "A Proposed Design for a Rapid Prototyping Language," Technical Report NPS 52-89-045, Naval Postgraduate School, 1989.

Luqi, B. Kraemer, V. Berzins, "Software Analysis and Testing through Prototyping," Technical Report NPS 52-89-044, Naval Postgraduate School, 1989.

Luqi, V. Berzins, "Issues in Language Support for Rapid Prototyping," Technical Report NPS 52-89-026, Naval Postgraduate School, 1989.

Luqi, V. Berzins, "Rapid Prototyping Languages in Computer Aided Software Engineering," Technical Report NPS 52-89-021, Naval Postgraduate School, 1989.

THESES DIRECTED: B. Douglas, LT, USN, "A Design Database for a Computer Aided Prototyping System," Master's Thesis, March, 1989.

L. Wyrick, LT, USN, "Evaluation of Technology Transfer: Conventional DBMSs to Object-Oriented DBMSs," Master's Thesis, March, 1989.

DEVELOPMENT OF A PROTOTYPE MOBILITY EXPERT SYSTEM FOR LAND LOCOMOTION

R.B. McGhee, Professor, Department of Computer Science
N.C. Rowe, Associate Professor, Department of Computer Science
M.J. Zyda, Associate Professor, Department of Computer Science
S.H. Kwak, Adjunct Research Professor,
Department of Computer Science
Sponsor: TEXCOM, U.S. Army

OBJECTIVE: Develop a prototype mobility expert system for land locomotion to serve as a decision aid for TEXCOM in support of its current military system testing mission at Fort Hunter-Liggett, California. Software to be configured to run on advanced workstations designed for artificial intelligence and computer graphics applications.

SUMMARY: This is an ongoing, multiple year project which is currently scheduled for completion in FY90. During the past year, work was concentrated on three topics: 1) planning energy - optimal paths for off-road vehicles, 2) developing an advanced simulation facility for off-road vehicles involving a vehicle driver and a vehicle commander, either or both of which may be replaced by an expert system, and 3) improving tools for graphical simulation.Progress on the first topic is reported in the Ph.D. dissertation of R.S. Ross listed below. A prototype interactive off-road vehicle simulator is described in the thesis of Shannon and Teter, also listed below. Work on the third topic was completed by Brown University on a subcontract basis.

THESES DIRECTED: Ron R. Ross, MAJ, USA, "Planning Minimum-Energy Paths in an Off-Road Environment with Anisotropic Traversal Costs and Motion Constraint," Ph.D. Dissertation, June 1989.

L.R. Shannon, CPT, USMC, and W.A. Teter, MAJ, USA, "An Autonomous Platform Simulator (APS)," Master's Thesis, June 1989.

COMPUTER VISION AND RULE-BASED CONTROL FOR ROBOTIC VEHICLES

R.B. McGhee - Professor of Computer Science,
Department of Computer Science
S.H. Kwak - Adjunct Research Professor
Department of Computer Science
Sponsor: Ohio State University

OBJECTIVE: Investigate the use of terrain data from an optical radar system to automatically determine suitable footholds for a hexapod walking machine. Use this data to develop rule-based control of stepping involving adaptation of rules to terrain types, including at least ditch crossing and negotiation of random obstacle fields. Participate in planning and evaluation of testing of the Adaptive Suspension Vehicle (ASV) walking machine at Ohio State University.

SUMMARY: Hexapod walking machines have demonstrated an ability to negotiate rough terrain unmatched by any other vehicle of comparable size. However, the problem of best utilizing vehicle legs to make use of available footholds while moving the vehicle body in a desired direction and speed has proved to be too difficult for human solution in real time. Experiments with the ASV vehicle at Ohio State University have proved conclusively that this problem can be solved by a computer using terrain data from an optical radar system. However, the algorithms used to date are limited to random obstacle fields and are very difficult to understand or modify. In this research project, the algorithms used by OSU have been recast into rule-based form and coded in Prolog. This has greatly facilitated understanding and has also resulted in improved performance. A paper detailing this work has been accepted for publication as indicated below. A second paper reporting a successful extension of this work to include large obstacles such as ditches is in preparation.

PUBLICATIONS: S.H. Kwak and R.B. McGhee, "Rule-Based Motion Coordination for a Hexapod Walking Machine," Advanced Robotics, Forthcoming, 1990.

S.H. Kwak and R.B. McGhee, "Rule-based Control of Stepping for a Hexapod Walking Machine with Ternary Terrain Classification," to be submitted to IEEE Journal of Robotics and Automation.

COMPUTER PLANNING OF MISSILE PATHS USING DISCRETE OPTICS ANALOGS

N. C. Rowe - Associate Professor of Computer Science
Department of Computer Science
Sponsor: Naval Air Systems Command (Direct Funding)

OBJECTIVE: Investigate algorithms for finding energy-minimizing and concealment-maximizing paths above highly contoured terrain, for simple models of cruise missiles.

SUMMARY: We explored a new approach to finding safe and minimal-energy three- dimensional paths by extending our past work on traversal of surfaces to the full three-dimensional problem. Our approach creates irregular polyhedral regions in airspace of homogeneous visibility from a set of fixed observers, by partitioning airspace with planes through the observers and tops of hills and ridges. Within such regions the optimal paths must be straight, and the remaining problems are finding optimal turns and optimal sequences of adjacent regions; we used an analogy to Snell's Law of optics to attack the first, and artificial intelligence search techniques to attack the latter. In 1989, we obtained a partial implementation of these ideas for paths above 50 meters from the ground. We also explored a different approach that will save calculation time by constructing "optimal-path maps" in advance.

PUBLICATIONS: R. Alexander and N. C. Rowe, "Path planning by optimal-path-map construction for homogeneous-cost two-dimensional regions," Technical Report NPS 52-90-002, Naval Postgraduate School, February 1990.

CONFERENCE PRESENTATION: N. C. Rowe and D. H. Lewis, "Vehicle Path-Planning using Optics Analogs for Optimizing Visibility and Energy Cost," NASA Conference on Space Telerobotics, Pasadena CA, February 1989.

THESES DIRECTED: L. Wrenn, CPT, USMC, "Three-Dimensional Route Planning for a Cruise Missile for Minimal Detection by Observers," Master's Thesis, June 1989.

R. Alexander, MAJ, USA, "Construction of Optimal-Path Maps for Homogeneous-Cost- Region Path-Planning Problems," Ph.D. Dissertation, September 1989.

AN ENVIRONMENT FOR SOFTWARE FAILURE REGION ANALYSIS

T.J. Shimeall - Assistant Professor of Computer Science
Department of Computer Science
Sponsor: Naval Postgraduate School Research Council

OBJECTIVE: To refine software testing theories by development of tools to study the failure behavior of software.

SUMMARY: The problem of selecting software test data is how to select the fewest necessary data sets to obtain a good estimate of the correctness of a piece of software. Current techniques require so many data sets that complete application of these techniques on non-trivial software is impossible. In FY89, this project developed a method for analyzing software to determine the set of inputs that generate program failures. This method reduces the number of data sets that need to be applied to test software by identifying the portion of the program input space that is affected by the faults in the program. In FY89, three software tools were specified and designed to support this method. Prototypes of the first two of these tools have been constructed (one tool, REACHER, in conjunction with LCDR R. Griffin, USN). The third prototype tool is now being completed. A Master's Thesis study using this analysis method is currently underway, with expected completion in June 1990.

PUBLICATIONS: "REACHER -- A Reachability Condition Derivation Tool," Technical Report, Naval Postgraduate School, NPS 52-89-050, September 1989.

"FALTER -- A Fault Annotation Tool," Technical Report, Naval Postgraduate School, NPS 52-89-051, September 1989.

CONFERENCE PRESENTATION: "Derivation of Software Failure Regions," Informal presentation at the Third Symposium on Software Testing, Analysis and Verification, Key West, Florida, December, 1989.

THESIS DIRECTED: "Derivation Strategies for Experienced- Based Test Oracles," Jose A. Hernandez, CPT, USMC, Master's Thesis, December 1989.

ARGOS: DESIGN AND DEVELOPMENT OF MULTIMEDIA DATABASE SYSTEMS IN SUPPORT OF THE PAPERLESS SHIP

C.T. Wu - Associate Professor of Computer Science
Department of Computer Science
Sponsor: NAVSEA, Chief Engineer of the Navy of Logistics

OBJECTIVE: Develop an information management system that supports a multimedia interface. Investigate the effectiveness of using oject-oriented approach in developing such system.

SUMMARY: Our implementation effort clearly indicates the object-oriented approach is very effective in rapidly developing a prototype information management system. We have been successful in developing system components in a modular fashion such that a new module can be developed and attached to the shole system easiy. Theree major components are developed during this period: Administration, Technical Manual, and PMS module. The PMS Module contains full database on FFG class ship. It has attracted strong interest in the DoD community.

PUBLICATIONS: C.T. Wu, P.Nardi, H. Turner, and D. Antonopoulos, "ARGOS: Next Generation Shipboard Information Management System," Technical Report, NPS 52-90-006, December 1989.

C.T. Wu, H. Turner and D. Antonopoulos, "ARGOS: PMS Module User Manual," Technical Report, NPS 52-90-015, December 1989.

THESES DIRECTED: W.R. Ault, LT, USN, "Design and Implementation of an Operations Module for the ARGOS Paperless Ship System," Master's Thesis, June 1989.

R. Hess, LT, USN, "The Administration Module of the ARGOS System," Master's Thesis, September 1989.

GRAPHICS LANGUAGE FOR ACCESSING COMMAND DATABASE

C.T. Wu - Associate Professor of Computer Science
Department of Computer Science
Sponsor: NAVDAC (Direct Funding)

OBJECTIVE: Develop a visual interface to a backend database system that is capable of supporting both data definition and data manipulation languages.

SUMMARY: During the period covered, we have developed three components. The first is the context-sensitive, hypertext help system. The second is the bitmap data to the database. The third is the query facility capable to retrieve data from the backend data base server over the Ethernet network. The interface system is built on PC AT-compatible machines.

PUBLICATIONS: C.T. Wu and D.K. Hsiao, "Implementing Visual Database Interface by Using and Object-Oriented Language," Proceedings of IFIP TC-2 Working Conference on Visual Database Systems, Tokyo, Japan, April 1989, pp. 105-126.

C.T. Wu, "Benefits of Object-Oriented Approach in Implementing Visual Database Interface," Journal of Object-Oriented Programming, Forthcoming.

C.T. Wu. "The Development of Visual Database Interface," Richard Wiener and Lewis Pinson (Editors), Applications of Object-Oriented Programming, Forthcoming.

CONFERENCE PRESENTATION: C.T. Wu, "Implementing Visual Database Interface by Using an Object-Oriented Language," Proceedings of IFIP TC-2 Working Conference on Visual Database Systems, Tokyo, Japan, April 3-7, 1989.

THESES DIRECTED: H.R. Fore, CPT, USA, "Prototyping Visual Interface for Maintenance and supply Databases," Master's Thesis, June 1989.

L. Yeary, CPT, USMC, "Design and Implementation of a Hypertext Help System for the GLAD," Master's Thesis, June 1989.

T. Hogan, LT, USN, "Interconnection of the GLAD to the Multi-Lingual, Multi-Model, Multi-Backend Database System Over an Ethernet Network," Master's Thesis, December 1989.

W. Sympson, "Graphic Language Interface for a Multi-Lingual, Multi-Model, Multi-Backend Database System," Master's Thesis, December 1989.

EFFICIENT FINE-GRAINED SCHEDULING OF RECURRENCE LOOPS

Amr M. Zaky - Assistant Professor of Computer Science
Department of Computer Science
Sponsor: Naval Postgraduate School Research Council

OBJECTIVE: To extend current methodologies for efficient execution of recurrence loops on Very Long Instruction Word architectures.

SUMMARY: Recurrence loops are very common to programs in certain application domains; e.g., in signal processing. While recurrence loops can contribute significantly to the overall execution time of a program having them, they do not possess the loop level parallelism exhibited by DOALL/ FORALL loops. On the other hand, research has shown that the execution times of recurrence loops can be significantly enhanced by exploiting the fine-grained parallelism inherent in them. Very Long Instruction Word (VLIW) architectures exploit the fine-grained parallelism available in a program and thus present a viable candidate for the efficient execution of recurrence loops. In this research, a methodology for the efficient execution of recurrence loops on VLIW architecture is investigated. A practical realization of this methodology will be evaluated by both the quality of the produced fine-grained schedules, and the complexity of the algorithms employed in producing them.

PUBLICATION: Amr M. Zaky and P. Sadayappan, "Optimal Static Scheduling of Sequential Loops on Multiprocessors," Proceedings of the 1989 International Conference on Parallel Processing, Chicago, August 1989.

LINE-OF-SIGHT AND VISUAL ENHANCEMENTS TO THE MOVING PLATFORM SIMULATOR

Michael J. Zyda - Associate Professor of Computer Science
Department of Computer Science
Sponsor: US Army Test and Experimentation Command

OBJECTIVE: The Graphics and Video Laboratory of the Department of Computer Science at the Naval Postgraduate School is currently conducting research on terrain visualization through the production of a system called the Moving Platform Simulator (MPS). That simulator uses Defense Mapping Agency digital terrain elevation data on commercially available, high-performance, graphics workstations. The thrust of the current effort is to enhance the MPS-2 system by adding in TEC position-location data streams. An additional set of tasks concerns the computation of player visibilities from each vehicle in the simulator.

SUMMARY: The work accomplished for this project so far is the design of a merged version of the Moving Platform Simulator, MPS-3. MPS-3 is to be a version of our vehicle simulator containing the best features of MPS-1 and MPS-2. The network format of MPS-3 is being modified to accommodate Simnet formatted packets. The intervisibility computations are being off-loaded to the second of two parallel processors. Graphics workstation performance measurements have been made and published for both MPS-1 and MPS-2. Work has been done on utilizing a three-dimensional digitizer camera for the generation of polygonally defined vehicles for the simulator displays.

PUBLICATION: Michael J. Zyda, "3D Visual Simulation for Graphics Performance Characterization," Computer Graphics '90 Conference Proceedings, Forthcoming.

CONFERENCE PRESENTATION: Michael J. Zyda, "Inexpensive Three-Dimensional Visual Simulation as Workstation Exhaustion," Graphics Colloquium at the University of California, Santa Cruz, California, October 27, 1989.

THESIS DIRECTED: Michael J. DeHaemer Jr., LT, USN, "Simplification of Objects Rendered by Polygonal Approximations," M.S., December 1989.

REAL-TIME, INTERACTIVE VISUAL SIMULATION FOR THE FUTURE COMMAND AND CONTROL WORKSTATION - YEAR 2

Michael J. Zyda - Associate Professor of Computer Science
Department of Computer Science
Sponsor: Naval Underwater Systems Center (Direct Funding)

OBJECTIVE: The Graphics and Video Laboratory in the Department of Computer Science at the Naval Postgraduate School is designing and implementing a prototype command and control system utilizing three-dimensional, real-time interactive graphics on high-performance, commercially available graphics workstations. The primary goal of this work is to develop real-time visualization tools and techniques useful for rapidly producing three- dimensional scenes such as would be seen from the bridge of a surface ship, the cockpit of an airplane, the periscope of a submarine and the bridge of a submarine (synthetic view).

SUMMARY: Work has continued on this project on a number of fronts. A Lego-blocklike system was constructed to facilitate the rapid generation of three-dimensional ship icons. A toolkit for the rapid generation of visual interfaces was prototyped. Work was performed on reducing the total number of polygons in ship models, models generated by a three-dimensional digitization process. Work has begun on the display of an air picture in the CCWF system.

PUBLICATION: Michael J. DeHaemer Jr. and Michael J. Zyda, "Simplification of Objects Rendered by Polygonal Approximations," Sixth Annual Symposium on Computational Geometry, October 31, 1989.

THESES DIRECTED: Michael J. DeHaemer Jr., LT, USN, "Simplification of Objects Rendered by Polygonal Approximations," Master's Thesis, December 1989.

Susan L. Dunlap, LT, USN, "A Toolkit for Designing User Interfaces," Master's Thesis, December 1989.

Daniel E. Nagel, LT, USN, "3DShips: Rapid 3D Icon Generation for the Command and Control Workstation of the Future," Master's Thesis, December 1989.

TERRAIN VISUALIZATION AND REASONING

Michael J. Zyda - Associate Professor of Computer Science
Department of Computer Science
Sponsor: Headquarters, Department of the Army AI Center

OBJECTIVE: The Department of Computer Science at the Naval Postgraduate School is currently conducting research on terrain visualization and reasoning using a combination of high-performance graphics workstations and expert systems running on Lisp machines. This projects requests a contin- uation of that work, with particular emphasis on the following areas: terrain visualization, terrain reasoning and knowledge representation/exploitation of terrain databases.

SUMMARY: Work was performed on this project on advanced terrain visualization and reasoning. A photogrammetrically derived, high-resolution terrain database was examined for its capability of providing terrain texturing information. That texturing information was used for generating advanced displays, displays of a higher precision than those currently available in the MPS-1 system.

PUBLICATIONS: Michael J. Zyda, William O. Breden and James J. Zanoli, "Graphics Workstations, 3D Visual Simulation and Photogrammetrically Generated Terrain Databases," submitted to Computer Vision, Graphics and Image Processing, November 1989.

INEXPENSIVE, REAL-TIME 3D TERRAIN VISUALIZATION

Michael J. Zyda - Associate Professor of Computer Science
Department of Computer Science
Sponsor: US Army Engineer Topographic Laboratories

OBJECTIVE: The Graphics and Video Laboratory of the Department of Computer Science at the Naval Postgraduate School is currently conducting research on terrain visualization through the production of a system called the Moving Platform Simulator (MPS). That simulator uses Defense Mapping Agency digital terrain elevation data on commercially available, high-performance, graphics workstations. The thrust of the current effort is to integrate the MPS system with the terrain databases and network protocols of the DARPA SIMNET system.

SUMMARY: Simnet formatted terrain databases were examined for their integration into the Moving Platform Simulator system. The performance of the modified MPS system was benchmarked. Beginning work was performed on modifying the network packet format of the MPS system to that of the DARPA Simnet system. Terrain database quality issues were probed.

PUBLICATIONS: Michael J. Zyda, "3D Visual Simulation for Graphics Performance Characterization," Computer Graphics '90 Conference Proceedings, Forthcoming.

Michael J. DeHaemer Jr. and Michael J. Zyda, "Simplification of Objects Rendered by Polygonal Approximations," extended abstract submitted to the Sixth Annual Symposium on Computational Geometry 31 October 1989.

Michael J. Zyda, William O. Breden and James J. Zanoli, "Graphics Workstations, 3D Visual Simulation and Photogrammetrically Generated Terrain Databases," submitted to Computer Vision, Graphics and Image Processing, November 1989.

Michael J. Zyda, Mark A. Fichten and David H. Jennings, "Performance Expectations and Measurements for Workstation-Based 3D Visual Simulation," submitted to IEEE Computer Graphics & Applications, October 31, 1989.

CONFERENCE PRESENTATION: Michael J. Zyda, "What We Need to Know to Build Inexpensive 3D Visual Simulators in the Future," Workshop on Standards for the Interoperability of Defense Simulators, Institute for Simulation and Training, University of Central Florida, Orlando, Florida, August 22 -23, 1989.

THESES DIRECTED: Michael J. DeHaemer Jr., LT, USN, "Simplification of Objects Rendered by Polygonal Approximations," Master's Thesis, December 1989.

THE INTEGRATION OF A HIGH RESOLUTION DIGITAL TERRAIN DATABASE WITH THE MOVING PLATFORM SIMULATOR

Michael J. Zyda - Associate Professor of Computer Science
Department of Computer Science
Sponsor: US Army Test and Experimentation Command

OBJECTIVE: The Graphics and Video Laboratory of the Department of Computer Science at the Naval Postgraduate School is currently conducting research on terrain visualization through the production of a system called the Moving Platform Simulator (MPS). That simulator uses Defense Mapping Agency digital terrain elevation data on commercially available, high-performance, graphics workstations. The thrust of the current effort is to integrate a high-resolution digital terrain database with the MPS simulator. An additional set of tasks concerns the computation of player visibilities from each vehicle in the simulator.

SUMMARY: The MPS-1 system was modified to utilize higher resolution digital terrain databases. A system, MPS-2, was produced that displays views of Fort Hunter-Liggett at 12.5, 25, 50 and 100 meter samplings. The MPS-2 system explored the use of triangular meshes with respect to graphics workstation performance measurements. Variants of the MPS-1 and MPS-2 systems were developed for post-crash flight analysis and for field artillery forward observer simulation training. A display system for a high resolution (1 foot samples) terrain database was developed and its performance was benchmarked. A real-time intervisibility computation module was developed as part of MPS-2.

PUBLICATIONS: Michael J. Zyda, Mark A. Fichten and David H. Jennings, "Meaningful Graphics Workstation Performance Measurements," Computers & Graphics, Forthcoming.

Michael J. Zyda, Robert B. McGhee, Corinne M. McConkle, Andrew H. Nelson and Ron S. Ross, "A Real-Time, Three-Dimensional Moving Platform Visualization Tool," Computers & Graphics, Vol. 14, No. 2.

Michael J. Zyda, William O. Breden, and James J. Zanoli, "Graphics Workstations, 3D Visual Simulation and Photogrammetrically Generated Terrain Databases," submitted to Computer Vision, Graphics and Image Processing, November 1989.

Michael J. Zyda, Mark A. Fichten and David H. Jennings, "Performance Expectations and Measurements for Workstation-Based 3D Visual Simulation," submitted to IEEE Computer Graphics & Applications, October 1989.

Michael J. Zyda, Mark A. Fichten and David H. Jennings, "Graphics Workstations and 3D Visual Simulation: Some Performance Expectations and Measurements," Technical Report NPS 52-89-046, July 1989.

CONFERENCE PRESENTATION: Michael J. Zyda, "Visual Simulation Research at the Naval Postgraduate School (Meaningful Graphics Workstation Performance Measurements)," Sun Microsystems, Mountain View, California, March 28, 1989.

THESES DIRECTED: William O. Breden, CPT, USA and James J. Zanoli, CPT, USA, "Visualization of High Resolution Digital Terrain," Joint Master's Thesis, June 1989.

Mark J. Christian, CPT, USA, "Post Crash Flight Analysis: Visualizing Flight Recorder Data," Master's Thesis, June 1989.

William T. Drummond Jr., CPT, USA and Joseph P. Nizolak Jr., CPT, USA, "A Graphics Workstation Field Artillery Forward Observer Simulation Trainer," Joint Master's Thesis, June 1989.

Randolph P. Strong, CPT, USA and Michael C. Winn, CPT, USA, "The Moving Platform Simulator II: A Networked Real-Time Visual Simulator with Distributed Processing and Line-of-Sight Displays," Joint Master's Thesis, June 1989.

REAL-TIME, INTERACTIVE VISUAL SIMULATION FOR THE FUTURE COMMAND AND CONTROL WORKSTATION

Michael J. Zyda - Associate Professor of Computer Science
Department of Computer Science
Sponsor: Naval Underwater Systems Center (Direct Funding)

OBJECTIVE: The Graphics and Video Laboratory in the Department of Computer Science at the Naval Postgraduate School is designing and implementing a prototype command and control system utilizing three-dimensional, real-time interactive graphics on high-performance, commercially available graphics workstations. The primary goal of this work is to develop real-time visualization tools and techniques useful for rapidly producing three-dimensional scenes such as would be seen from the bridge of a surface ship, the cockpit of an airplane, the periscope of a submarine and the bridge of a submarine (synthetic view).

SUMMARY: Initial work was performed on the development of the Command and Control Workstation of the Future (CCWF). The focus of the NUSC effort was on developing a three-dimensional, geometric view of the sea bottom as generateable from evenly spaced terrain bottom elevation data. The developed CCWF system was integrated into the networking scheme used in the MPS-1 and MPS-2 systems. The CCWF system explored new viewing algorithms. The CCWF system was benchmarked on a variety of workstations, under a number of configurations.

CONFERENCE PRESENTATIONS: Michael J. Zyda, "Visual Simulation Research at the Naval Postgraduate School (Meaningful Graphics Workstation Performance Measurements)," The Third Naval Digital MC&G Interest Group Meeting, sponsored by the Naval Ocean Research and Development Activity, Stennis Space Center, Bay St. Louis, Mississippi, February 1 - 2, 1989.

Michael J. Zyda, "Meaningful Graphics Workstation Performance Measurements," NECUSE (New England Consortium for Undergraduate Science Education) Workshop on Computer Graphics, Wellesley College, Wellesley, Massachusetts, January 20 - 21, 1989.

THESIS DIRECTED: Charles E. Phillips Jr., CPT, USA and Gordon K. Weeks Jr., LTjg, USCG, "The Command and Control Workstation of the Future: Subsurface & Periscope Views," Joint Master's Thesis, June 1989, NPS 52-89-037.

INEXPENSIVE, THREE-DIMENSIONAL VISUAL SIMULATION FOR THE FUTURE COMMAND AND CONTROL WORKSTATION

Michael J. Zyda - Associate Professor of Computer Science
Department of Computer Science
Sponsor: Naval Ocean Systems Center (Direct Funding)

OBJECTIVE: The Graphics and Video Laboratory in the Department of Computer Science at the Naval Postgraduate School is designing and implementing a prototype command and control system utilizing three-dimensional, real-time interactive graphics on high-performance, commercially available graphics workstations. The primary goal of this work is to develop real-time visualization tools and techniques useful for rapidly producing three-dimensional scenes such as would be seen from the bridge of a surface ship, the cockpit of an airplane, the periscope of a submarine and the bridge of a submarine (synthetic view). An additional goal of this project is a continuation of the development of a software architecture for interactive, real-time graphics between workstations on the same network.

SUMMARY: Initial work was performed on the development of the Command and Control Workstation of the Future (CCWF). The focus of the NOSC effort was on developing a three-dimensional, geometric view of the sea surface and nearby terrain as generateable from evenly spaced terrain elevation data. The developed CCWF system was integrated into the networking scheme used in the MPS-1 and MPS-2 systems. The CCWF system explored new viewing algorithms. The CCWF system was benchmarked on a variety of workstations, under a number of configurations.

CONFERENCE PRESENTATION: Michael J. Zyda, "Visual Simulation Research at the Naval Postgraduate School (Meaningful Graphics Workstation Performance Measurements)," The Third Naval Digital MC&G Interest Group Meeting, sponsored by the Naval Ocean Research and Development Activity, held at the Stennis Space Center, Bay St. Louis, Mississippi, February 1 - 2, 1989.

THESES DIRECTED: Steven A. Munson, LT, USCG, "Integrated Support for Manipulation and Display of 3D Objects for the Command and Control Workstation of the Future," Master's Thesis, June 1989.

Charles E. Phillips Jr., CPT, USA, and Gordon K. Weeks Jr., LTjg, USCG, "The Command and Control Workstation of the Future: Subsurface & Periscope Views," Joint Master's Thesis, June 1989.

DEFENSE RESOURCES MANAGEMENT EDUCATION CENTER

Defense Resources Management Education Center

The Defense Resources Management Education Center (DRMEC) is a DoD sponsored tenant activity located at the Naval Postgraduate School. The mission of the Center is to conduct resources management short courses for mid to senior-level officers and civilians from the U.S. and allied nations. Since 1965, over 11,000 U.S. and 5,000 international participants have attended DRMEC courses.

The faculty of the Center are faculty of NPS and, as such, engage in a wide variety of research programs in support of the DoD mission. Current areas of faculty research include: Soviet Public Expenditure Decisions (Professor Earl Brubaker); Integrating Manpower Concerns in the Acquisition Process (Associate Professor Boynton); The Impact of Defense Expenditures on Economic Growth (Professor Peter Frederiksen and C. J. LaCivita); Economic Development of Third World Countries (Professor Peter Frederiksen); Applying the Theory of Differential Games to Model Bi-lateral US/USSR Defense Expenditures (Associate Professor Francois Melese); Systemic and Demographic Approach to Federal Budgeting (Professor John Dawson); Development of Outlay Forecasting Models for DoD Planning and Budgeting (Associate Professor Kent Wall and Associate Professor LaCivita); Underlying Trends in American Alignments (Associate Professor Darnell Whitt); Strategic Planning Forecasting System for the JCS (Professor Robert von Pagenhardt); Evolution and Consequences of Trust and Betrayal in Organizations (Associate Professor James Morris); DoD Manpower Issues (Professor James Blandin).

FORECASTS SYSTEM II

R. Von Pagenhardt, Professor of Defense Resources Management Education Center
Sponsor: Naval Regional Contracting Center

OBJECTIVE: The purposes of the microcomputer-based FORECASTS System II are to assist a strategic planner/analyst to: 1) Anticipate long-range threat to the security of our Nation, allies, friends, interests and objectives; 2) Identify the trends developments or events that could lead to further international crisis and conflicts, as well as opportunities for cooperation; 3) Line strategic means ends for planning purposes in order to overcome future threat and achieve national objectives; and 4) Recommend opportunities for proactive or counter-measures, and access the likely future consequences of those actions.

The current objective is to create, test, and validate a "Beta" version of FCII. It will certainly require another year or two to make it as "user friendly" and as sophisticated an "expert system" as DRMEC wants to provide for the national security affairs community and US Government.

SUMMARY: During the past year, DRMEC in cooperation with the JDSSC and with the advice of the Systems application, Inc., (SAI) has specified the desired functions of the system, created the system specifications, and monitored the encoding of the software. DRMEC since October has been testing and evaluating major parts of the system, but has yet to receive the system in its entirety. Project design and management as well as system integration have been our major concerns throughout the years. Models and submodels were examined and approved as well as most of the database. DRMEC anticipates success and will design and develop a course for users, but the faculty, investigators have yet to test the system as a whole. They will not validate the system for use by strategic planners until it is proven demonstratably helpful.

PUBLICATIONS: R. Von Pagenhardt, "Functional System Description and System Specification," In Progress.

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

INTRODUCTION

The research program of the Department of Electrical and Computer Engineering involves projects in the following areas: Communications, Computer Engineering, Electromagnetics, Electro-Optics, Radar and Electronic Warfare, Signal Processing, Systems and Controls, and Underwater Acoustics. Some research projects span one or more of these areas, although they are listed here in only one catagory. Graduate students are involved in virtually all efforts, as indicated by the titles of published theses that are listed with the project descriptions.

COMMUNICATIONS

Professor Tri Ha investigated the communications function and the networking of tactical low-altitude satellites (LASAT) in random orbits.

Professor Ha also continued research in tactical data networks by investigating the performance of Aloha mobile radio networks including near/far effect and fading. The analysis demonstrated that the near/far effect and the Rayleigh fading improve the throughput of the Aloha channel considerably.

In a closely related effort, Professor Clark Robertson investigated the capabilities of the pseudo-Bayesian slotted Aloha system for mobile communication applications, including the effects of multipath and the near/far effect.

Professor Glen Myers investigated means of synchronizing two FSK/QPSK demodulators. A laboratory hardware system was designed, built and tested to verify the computer results and to obtain data on the performance of the associated phase-locked-loop.

Professor Paul Moose considered the development of a high data rate packet communication technique and began identifying the limiting channel parameters of an acoustic link for a critical Naval application. Real time hardware was developed using PC/AT personal computers which is operating in a laboratory through a simulated acoustic channel.

Professor Stephen Jauregui continued involvement in a program to enhance signals and decrease noise at US Navy HFDF and aquisition sites. This was accomplished by collecting data on site and determining a variety of mitigating techniques.

COMPUTER ENGINEERING

Professor Herschel Loomis conducted research into computer algorithms and architectures for the processing of tactical information, including the case of spaceborne computer systems.

Professor Loomis also investigated computer aided design (CAD) techniques for complex VLSI chips to achieve high performance or special functionality. Custom chip architectures for portions of a spaceborne processor under development for SPAWAR are being designed.

Professor Chin-Hwa Lee applied the Graph Partitioning Algorithm using a dynamic programming method for track detection. This technique was compared with conventional methods in terms of its sensitivity to a low power signal in the presence of high power noise.

Professors Jon Butler and Chyan Yang developed logic synthesis techniques for multiple-valued combinational logic and developed multiple-valued storage elements. A significant step forward was made by the development of a voltage-mode multiple-valued delay flip-flop.

Professor Butler also continued development of multiple-valued CCD/CMOS devices and also developed efficient synthesis algorithms for programmable logic arrays using the SUM operator.

In addition, Professor Butler developed synthesis techniques for a new multiple-valued logic technology, current-mode CMOS. A computer-aided design (CAD) tool that was initiated by two NPS M.S. students was improved.

Professor Yang continued the design of a CAD tool to assist digital designers in rapidly performing timing verifications at the prototyping stage. Also explored was the parallel processing benefit and its applicability to the design verification.

Professors Yang and Loomis investigated silicon compiler techniques and test methods for the design of complex spaceborne digital processors in Navy applications. A first attempt at using a silicon compiler in designing notch filters produced numerous experimental results.

ELECTROMAGNETICS

Professor Richard Adler established the effects of nearby ground conditions on the low-angle performance of a new class of complex HF communication antennas. The study reveals unexpected and undesired pattern degradation over the frequency range of 4 to 5.5 MHz for a combined conical monopole/log-periodic array.

A new class of Navy missile radomes, constructed from inhomogeneous materials, is being developed to minimize boresight tracking errors at low frequencies. Professor Michael Morgan continued development of a CAD-based finite element computer program for evaluating the electromagnetic performance of these types of radomes.

Professor Harry Atwater derived circuit models for selected discontinuity elements in the shielded suspended substrate transmission format. This is a preferred transmission medium for Ka-band (30-GHz and above), due to its low loss, good isolation, and good potential for filter circuit applications.

Professor Jeffrey Knorr began developing CAD compatible circuit models for finline and finline discontinuities, such as the inductive strip. Numerical data derived from spectral domain programs is being used to determine parameter values for equivalent circuit elements.

Professor Rama Janaswamy investigated the possibility of using new structures for the tapered slot antenna. A rigorous model for the characteristics of a millimeter wave transmission line (the Bilateral Slotline) was developed.

Professor Janaswamy also considered new structures for implmenting the tapered slot antenna for microwave/millimeter wave integrated circuits.

Professor Hung-Mou Lee continued his investigation of the excitation of internal resonant modes of a cavity by an incident plane wave. Analytical results on the scattering by a tubular cylinder of finite length were obtained and compared with experimental data.

ELECTRO-OPTICS

Professor John Powers continued development of electro-optical techniques to measure particle size data within the combustor and across the exhaust nozzle of solid propellant rocket motors. Both experimental and computational aspects were considered for retrieval of particle size from holograms.

RADAR AND ELECTRONIC WARFARE

Professor Michael Morgan continued research in radar target identification using aspect-independent annihilation filtering of natural resonances. Two new signal processing algorithms were considered for estimation of resonances in noisy radar scattering data and were applied to scale model aircraft targets.

Professors Stephen Jauregui and Richard Adler developed and tested techniques for passive target location using various methods, including HFDF, SSL, differential doppler, time difference of arrival and Aydrid techniques. In addition, they developed and tested signal acquisition techniques.

Professor Hung-Mou Lee continued his investigation of the effects of ducting and the curvature of Earth on sea clutter up to the vicinity of the radar horizon. A theoretical framework is being developed so that the propagation of radio waves up to the vicinity of the radar horizon can be accurately and conveniently formulated and solved.

Professor Harold Titus investigated the simulation of designated Soviet missiles and missile radars. In addition, industrial proposals for developing look-alike models of the Soviet systems were evaluated.

Professor Titus also investigated optimal methods of chaff placement and ship maneuver for ship defense against ASCM. Computer simulation programs were developed to simulate a ship's defense against cruise missiles.

Professor Donald Wadsworth began the design and evaluation of clutter suppression algorithms for processing target measurement data. Initial implementation of a signal processor simulation program was performed and subsequent evaluation of target data provided by Boeing is now being addressed.

SIGNAL PROCESSING

Professor Ralph Hippenstiel investigated the use of an averaged time-varying correlation function, including the effects of windowing of the correlation function, to obtain dynamic spectral estimates for non-stationary phenomena.

Professor Hippenstiel also performed an assessment of signal processing techniques employing Walsh and other rectangular basis functions in Soviet-bloc countries. This included the critical examination of over 140 publications.

Professor Monique Fargues considered the potential optimization of the C-Rite algorithm, which is designed to estimate the number and directions of unknown sources in a noisy environment using a passive linear array.

Professors Murali Tummala and Charles Therrien further investigated single vector, block and selective othogonalization algorithms of the Lanczos method, of use when there is need to estimate only a few of the extreme eigenvalues. Applications include high resolution spectral analysis and estimation of the direction-of-arrival of point sources in low signal-to-noise ratio environments.

Professors Therrien and Roberto Cristy continued development of a system for enhancement of images uring underwater recovery operations. The system uses a combination of real-time and non-real-time methods.

Professors Therrien, Tummala and Cristi researched structures and algorithms for modeling and filtering one-and two-dimensional signals using adaptive and Markov modeling. Some new 2-D adaptive algorithms were developed and applied to noise removal and coding in images.

SYSTEMS AND CONTROLS

Professor Harold Titus continued to design optimal control configurations for the Orion Spacecraft. Without a specific payload for Orion, it was necessary to design control configurations for various possibilities, such as spin stabilized, gravity gradient, gas jet, etc.

Professor Titus also applied smoothing algorithms to the Kalman filter tracking of torpedoes by acoustic arrays located in a grid on the ocean bottom.

Professor Jeffrey Burl continued to advance the theory, practice, and application of estimation and control of distributed parameter systems and large scale systems. Reduced order models generated both by the physics of the problem and empirically (system identification), have been found to be intimately linked with the control problem.

Professor Sherif Michael continued research on photovoltaic power technology. This work included the development and testing of a microprocessor based experiment suitable for small satellites, as well as investigation of photovoltaic current anncaling processes and other related topics involving radiation effects on GaAs, InP and Si devices.

Professor Michael also investigated the advantage of applying the new composite operational amplifier techniques for radiation hardening of analog networks, using the NPS Linear Accelerator.

In addition, Professor Michael began developing a microprocessor based portable tester for monitoring and detecting individual devices with degraded parameters in submarine power supplies.

Professor Alan Kraus developed a PC compatible computer code for evaluation of a temperature map of the NWSC Form-B Electronic Module using a conduction only thermal model. A 510 mode model was developed with an easy growth potential to 750 modes.

Professor Donald Wadsworth developed a computer simulation for synthesizing earth moon trajectories in support of a lunar base. This included flight-time vs. energy trades and guidance sensitivities for a class of transearth trajectories.

UNDERWATER ACOUSTICS

Professor John Powers applied spatial frequency domain techniques to modeling the propagation of pulsed and transient ultrasound waves in lossless and lossy media. The technique allows the application of computer-efficient FFT algorithms to problems that have previously used complicated line integrals for evaluation.

Professor Powers also continued design efforts for a multi-channel fiber optic data link from undersea experiments to shore using three approaches: (1) an analog link using FM optical carrier modulation; (2) a high-speed A/D converter to digitize data and; (3) use of code division multiplexing.

Professor Lawrence Ziomek continued the development of both a mathematical and a numerical ocean acoustic pulse-propagation model based on the principles of linear, time-variant, space-variant, random filter theory and the physics of wave propagation in random media.

Professors James Miller and Sonke Paulsen applied ocean acoustic tomography to the study of surface waves and internal waves in the ocean. A major accomplishment was the initial data reduction and analyses from a week-long experiment carried out in Monterey Bay.

Professors Miller and Ziomek continued a collaborative effort with the Oceanography Department, as sponsored by the Monterey Bay Aquarium Research Institute, to address the viability of a permanent ocean acoustic tomography monitoring system for Monterey Bay. Both experimental and modeling efforts were conducted.

LOW ANGLE HF COMMUNICATION ANTENNA PREDICTION AND VALIDATION

Richard W. Adler - Adjunct Professor of E.C.E.
Department of Electrical and Computer
Sponsor: Naval Security Group Command

OBJECTIVE: Establish the magnitude of the effects on low angle performance of the ground conditions nearby a new class of complex HF communication antennas.

SUMMARY: HF antenna performance for long distance ionospheric propagation-based communications is highly dependent on the electromagnetic interaction between the antenna and the lossy ground beneath the structure. Antenna /ground performance is calculated via a numerical electromagnetic model for a set of ground conditions that encompass operational sites ranging from arctic tundra to semi-desert conditions.

The study reveals unexpected and undesired pattern degradation over the frequency range of 4 to 5.5 MHz for a combined conical monopole/ log-periodic array. A simple vertical monopole with top-hat loading was modeled and produced similar results. The mechanism responsible for the loss of low angle (long distance) performance is identified. Future ground constant and radiation pattern measurements will verify the computer models and allow design changes to improve the operation of the antenna system.

THESIS DIRECTED: D. R. Dillon, CAPT, USMC, "Numerical Electromagnetics Code Modeling of a High Frequency Antenna Radiation in the Presence of Finite Ground," M.S. Thesis, December 1989.

MICROWAVE SUSPENDED STRIPLINE DISCONTINUITIES

Harry A. Atwater - Adjunct Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: Naval Ocean Systems Center

OBJECTIVE: Derive circuit models for selected discontinuity elements in the shielded suspended substrate transmission format.

SUMMARY: The shielded suspended substrate line format is a preferred transmission medium for Ka-band (30-GHz and above), due to its low loss, good isolation, and good potential for filter circuit applications. Very little information is currently available in literature on circuit models for typical dispecteduities such as the series gap, or step change in width. This research is directed toward obtaining frequency-dependent circuit models for discontinuities, to be used in computer-aided circuit design in the medium. The specific problems selected for the research program were motivated by engineering requirements specified by the Microwave Circuits Laboratory of the Naval Ocean Systems Center, San Diego. Results obtained during the reporting period (1989) are: the dispersive (frequency-dependent) propagation constant of the subject line medium, and a static model for the series gap. Progress was made toward the dispersive gap model, with results expected in the near future.

ON THE DESIGN OF MULTIPLE-VALUED CCD/CMOS VLSI CIRCUITS

Jon T. Butler - Professor of E.C.E.
Department of Electrical and Computer Engineering
H. G. Kerkhoff - Associate Professor
Department of Electrical Engineering, University of Twente, Enschedo,
The Netherlands
Sponsor: North Atlantic Treaty Organization

OBJECTIVE: To develop multiple-valued CCD/CMOS devices and to develop efficient synthesis algorithms for programmable logic arrays using the SUM operator.

SUMMARY: This is the continuation of an on-going project. Progress was made in the development of the costtable techniques for the synthesis of current-mode CMOS circuits, where logic values (typically 4) are encoded as current. A paper co-authored with Y. H. Chang is in preparation describing this.

PUBLICATIONS: P. T. Tirumalai, J. T. Butler, "Prime and Nonprime Implicants in the Numerization of Multiple-Valued Logic Functions," Proceedings of the 19th International Symposium on Multiple Valued Logic, May 1989, pp. 272-282.

COMPUTER-AIDED-DESIGN TOOLS FOR MULTIPLE-VALUED CURRENT-MODE CMOS VLSI

Jon T. Butler - Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: NPS Research Council in Cooperation With the
Naval Research Laboratory

OBJECTIVE: To develop synthesis techniques for a new multiple-valued logic technology, current-mode CMOS.

SUMMARY: A computer-aided design (CAD) tool initiated by two NPS M.S. students has been improved. Specifically, the analysis part of the package has been greatly expanded. Thus, analyses of certain algorithms which required several man days of labor, now can be done by typing a single command line. The package has been developed to the point where we are now making it available as public domain software.

PUBLICATIONS: J. M. Yurchak and J. T. Butler, "HAMLET - An Expression Computer/Optimizer for the Implementation of Heuristics to Minimize Multiple-Valued Programmable Logic Arrays,"

ON THE USE OF MULTIPLE-VALUED LOGIC IN THE DESIGN OF DIGITAL SYSTEMS

Jon T. Butler - Professor of E.C.E.
Chyan Yang - Assistant Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: NPS Research Council in Cooperation with the
Naval Research Laboratory

OBJECTIVE: To develop logic synthesis techniques for multiple-valued combinational logic and to develop multiple-valued storage elements.

SUMMARY: A significant step forward was made by the development of a voltage-mode multiple-valued delay flip-flop. A detailed study was made of a current-mode flip-flop published previously. Its performance was below our expectation and so both modifications to it, as well as an entirely new flip-flop resulting in improvements in speed and device count. Also, a new minimization algorithm , the neighboring decoupling algorithm, was developed which is superior to existing algorithms in minimizing sum-of-products expressions for realization by multiple-valued programmable logic arrays.

PUBLICATIONS: C. Yang and Y. Wang, "A Neighborhood Decoupling Algorithm for Truncated Sum Minimization," Submitted.

THESES DIRECTED: D. A. York, Lt. USN, "Multiple-Valued Storage Devices," Master's Thesis, December 1989.

Y.-M. Wang, Lt. Taiwanese Navy, "Truncated Sum Minimization Using the Neighborhood Decoupling Algorithm," Master's Thesis, December 1989.

DISTRIBUTED PARAMETER SYSTEM CONTROL USING REDUCED ORDER MODELING

Jeffrey B. Burl - Assistant Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: NPS Research Council

OBJECTIVE: Advancement of the theory, practice, and application of estimation and control of distributed parameter systems and large scale systems is the ultimate objective of this research. Reduced order models generated both by the physics of the problem and empirically (system identification), have been found to be intimately linked with the control problem. Therefore additional objectives are: Evaluate the control performance resulting from the use of various reduced order models and generate algorithms for the identification of a reduced order model that describes the dynamics of a general distributed parameter system. Emphasis was placed on generating models of sufficiently low order that they can be used with practical estimation and control algorithms, and also generating algorithms that require a reasonable amount of computation.

SUMMARY: The research encompassed both theory development in reduced order modeling (ROM) and the application of ROM techniques to specific problems: the control of large space structures and image processing. The theory development focused on enumerating the properties of a particular ROM scheme involving the Karhunen-Loeve expansion. The application portion focused on using computer simulation for the evaluation of various ROM schemes used in the control of large space structures. In addition, the ROM approach was employed on image models and found to yield a novel method for the filtering of moving images.

PUBLICATIONS: J. B. Burl, "Estimating the Basis Functions of the Karhunen-Loeve Transform," **IEEE Trans. on Acoustics, Speech, and Signal Processing,** vol. 37, no. 1, pp. 99-105, 1989.

J. B. Burl, T. M. Grogan, and W. J. Preston, "Effects of Reduced Order Modeling on the Control of a Space Station," Proceedings of the 1989 IEEE International Conference on Control and Applications, April, pp. RA-1-4, 1989.

J. B. Burl, "A Reduced Order Extended Kalman Filter for Moving Images," IEEE Trans. on Acoustic, Speech, and Signal Processing, In Progress.

J. B. Burl, "Reduced Order System Identification Using the Karhunen-Loeve Transform," Mathematics of Control, Signals, and Systems, In Progress.

CONFERENCE PRESENTATIONS: J. B. Burl, "Effects of Reduced Order Modeling on the Control of a Space Station," 1989 IEEE International Conference on Control and Applications, April 6, 1989.

THESES DIRECTED: T. M. Grogan, "Reduced Order Modeling of Large Space Structures Using the Karhunen- Loeve Modes," Master's Thesis, March 1989.

R. J. Irby, "Design of a Control System for the Rapid Retargeting/Precision Pointing (R2P2) Facility," Master's Thesis, September 1989.

P. A. Lindeman, "A Reduced Order Extended Kalman Filter for Moving Images," Master's Thesis, December 1989.

ADAPTIVE AND MARKOV MODELS FOR SIGNAL PROCESSING

R. Cristi - Associate Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: Office of Naval Research

OBJECTIVE: Investigate stochastic models of signals with discontinuities, and their applications to signal detection.

SUMMARY: Signals with discontinuities can be modeled by using two coexisting processes, one for the regions in which the signal is stationary, and one for the signal within each region. An estimation technique is developped which detects the discontinuities and estimates the signal within the regions without smoothing the edges. Application to the detection of underwater images show the effectiveness of the technique.

PUBLICATIONS: R. Cristi, "Markov and Recursive Least Squares Methods for the Estimation of Data with Discontinuities," IEEE Transactions on Acoustics, Speech and Signal Processing, Forthcoming (November 1990).

CONFERENCE PRESENTATIONS: R. Cristi, "Edge Detection by 2D Recursive Least Squares and Markov Random Fields," 6th Multidimensional Signal Processing Workshop, Asilomar Conference Grounds, Pacific Grove, CA, September 1989.

THESES DIRECTED: P. A. Merritt, "Segmentation and Edge Detection of Images by a PC Based Workstation," Master's Thesis, December 1989.

EXTENSIONS TO THE C-RITE APPROACH AND THEIR APPLICATIONS TO PASSIVE SIGNAL ESTIMATION

Monique P. Fargues - Assistant Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: NPS Research Council

OBJECTIVE: Investigate the potential optimization of a previously derived algorithm designed to estimate number and direction of unknown sources in a noisy environment using a passive linear array.

SUMMARY: In many applications, for example in radar or sonar, one is faced with the problem of resolving an unknown number of incoming signals, possibly closely spaced, in a noisy environment. High-resolution techniques use the information contained in the received signal and noise correlation matrices to estimate the number and the location of the incoming signals. One of the early limitations of those high-resolution techniques was in the computational load involved in the eigenstructure decomposition. However, the introduction of VLSI circuits has tremendously reduced the cost of computations and hardware implementations. As a consequence, algorithms capable of highly parallel and localized data flow, taking advantage of VLSI suitability, have become an active domain of research. This project extends works done earlier. The algorithmic procedure developed in this previous work exploits the special Hermitian Toeplitz structure of signal and noise correlation matrices to reduce the computation time needed to estimate the number and location of incoming signals using a passive linear array. The first phase of the work considered here involves the refinement of the iterative eigenvalue search technique involved in the algorithm. We will look at the quality of the approximants used for the iterative search portion of the algorithm and evaluate the optimum use of such interpolants. The second phase will involve the potential addition of an adaptive capability to the procedure. Adaptive algorithms which can update in time and forget the eigen-information by using new data samples are very useful for the tracking of movings signals. We will investigate the applicability of this addition to the original algorithm.

CONFERENCE PRESENTATION: M.P. Fargues and A.A. (Louis) Beex "Toeplitz-Derived Eigendecomposition," Proceedings of the 23rd Asilomar Conference on Signals, Systems, and Computers, Pacific Grove, CA Oct. 30 - Nov. 1, 1989.

RESEARCH IN LOW-ALTITUDE SATELLITE COMMUNICATIONS AND NETWORKS

Tri T. Ha - Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: Naval Ocean Systems Center

OBJECTIVE: Investigate the communications function and the networking of tactical low-altitude satellites (LASAT) in random orbits.

SUMMARY: Because LASAT's are designed to be used only on a crisis basis, these short-lived satellites have no station keeping to maintain coverage, Therefore, they constitute a random-orbit system. Such a random-orbit system requires a larger number of satellites to provide continuous coverage vis-a-vis well-defined orbits, where satellite station keeping is required. On the other hand, the random-orbit system increases the survivability of LASAT's considerably, assuming that they are hardened against radiation of nuclear detonation which may inflict damage in a sphere of radius of 10-100 km. An analytical approach has been used to derive the mean value of the number of LASAT's in view of a ground station as functions of the lowest and highest altitudes. In addition, the mean square value of the number of LASAT's together with the percentile value of the number of LASAT's in view have been obtained. Computer simulation verified the analytical results.

THESIS DIRECTED: T. M. Clemons III, LT, USN, "System Analysis of a Tactical Multi-Satellite System," Master Thesis, December, 1989.

RESEARCH IN TACTICAL DATA NETWORKS

Tri T. Ha - Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: Naval Ocean Systems Center

OBJECTIVE: Investigate the performance of mobile radio networks with near/far effect and fading.

SUMMARY: An analysis of the throughput of slotted and unslotted Aloha networks in a mobile environment has been obtained. Both near/far effect (between mobile users and the base station) and Rayleigh were considered. The analysis demonstrated that the near/far effect and the Rayleigh fading improve the throughput of the Aloha channel considerably. For unslotted Aloha, the channel is modeled as a random walk to obtain the distribution of the signal-to-interference ratio. A ring model with an adaptive retransmission strategy was developed to alleviate the long packet delay suffered by users located far from the base station. Investigation of the use of random two power levels to improve the throughput of the channel has also been considered. A throughput analysis of an adaptive stop-and-wait ARQ has also been carried out.

CONFERENCE PRESENTATIONS: R.L. Borchardt and T.T. Ha, "Analysis of Unslotted Random Access Channel in a Capture Environment," International Conference on Communication, Boston, MA, June 11-14, 1989.

T.A. Beck and T.T. Ha, "Capacity of a Land Mobile Satellite System," Aerospace Applications Conference, Denver, CO, Feb. 12-17, 1989.

J. T. McCartin and T.T. Ha, "Ring Model for Local Radio Communications," Global Telecommunications Conference, Dallas, TX, Nov. 27-30, 1989.

THESES DIRECTED: J.T. McCartin, CPT, USAF, "Performance Analysis of Aloha Networks with Power Capture and Near/Far Effects," Master Thesis, June 1989.

K.J. Guth, LT, USCG, "An Adaptive ARQ Strategy for Packet Switching Data Communications Networks," Master Thesis, June 1989.

D.T. Tsuda, CPT, USA, "Adaptive Go-Back-n: An ARQ Protocol for a Tactical VSAT Network," Master Thesis, Sept. 1989.

SPECTRAL ESTIMATION OF NON-STATIONARY PROCESSES

R. Hippenstiel, Assistant Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: Naval Ocean System Center, San Diego, Ca.

OBJECTIVE: Investigate the use of an averaged time-varying correlation function to obtain dynamic spectral estimates. Investigate the effects of windowing (weighting) of the correlation function.

SUMMARY: Many physical phenomena have the attributes of non-stationarity. The Navy in Underwater Surveillance problems is interested in detecting and classifying time-varying spectral components. The technique used in the investigation allows robust detection of the time-varying components. In the past the potentials of this processing technique was demonstrated with the 1989 efforts directed towards assessing the effects of properly weighting the terms used in the Instantaneous Power Spectrum. Some analytical results are derived and experimentally verified.

CONFERENCE PRESENTATIONS: R. Hippenstiel and P. Oliveira, "Contributions to Time-Varying Spectrum Estimation Using the Instantaneous Power Spectrum (IPS)", 1989. International Conference on Acoustic, Speech, and Signal Processing, Glasgow, Scotland, May 1989.

THESIS DIRECTED: "Instantaneous Power Spectrum", P. Oliveira, LT, Portuguese Navy, Electrical Engineer Thesis, March 1989.

WALSH FUNCTIONS AND RELATED RECTANGULAR BASIS FUNCTIONS

Ralph Hippenstiel, Assistant Professor of E.C.E.
Department of Electrical and Computer Engineering
Daniel Bukofzer, Associate Professor of E.E.
Electrical Engineering Dept., FRESNO State University
Sponsor: U.S. Army Foreign Science and Technology Center.

OBJECTIVE: Analysis and assessment of signal processing techniques in Communist countries. Projection of current and future applications and trends.

SUMMARY: Over 140 publications and references are examined in light of researchers involved and institutions involved. Connections with the goals of certain institutions are made and hypotheses about current and future applications and trends are provided. Hardware limitations, where possible are taken into consideration.

PUBLICATIONS: R. Hippenstiel and D. Bukofzer, "Walsh Functions and Related Rectangular Basis Functions," NPS technical report, NPS 62-89-024, Sept 1989.

DIFFRACTION BY HALF-PLANE LYING ON M-LAYERED MEDIUM

Rama Janaswamy, Assistant Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: NPS Research Council

OBJECTIVE: To investigate the possibility of using new structures for the tapered slot antenna.

SUMMARY: A rigorous model for the characteristics of a millimeter wave transmission line (the Bilateral Slotline) was developed. The model was based on the spectral Galerkin method for solving the Electric Field Integral Equation. Characteristics were developed for the wavelength and the characteristic impedance of the bilateral slotline for a given set of substrate parameters and frequency. For wide slotlines, an asymptotic method based on the Wiener-Hopf method was utilized. The bilateral slotline can be used in developing mm-wave antennas for phased array applications.

PUBLICATIONS: R. Janaswamy, "Even Mode Characteristics of the Bilateral Slotline," Accepted for publication, IEEE Trans. Microwave Theory Tech.

THESIS DIRECTED: G. Lambrakakis, Hellenic Navy, "Experimental Investigations of Some New Planar Antennas," Master's Thesis (ongoing)

NEW STRUCTURES FOR THE TAPERED SLOT ANTENNA

Rama Janaswamy, Assistant Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: Naval Weapons Center, China Lake

OBJECTIVE: To investigate new structures for implmenting the tapered slot antenna for microwave/millimeter wave integrated circuits.

SUMMARY: The tapered slot antenna is a wideband travelling wave antenna that is finding increase use in microwave/millimeter wave integrated circuits. Alternate structures will being explored for making these antennas compatible with integrated circuits. Task-1 of the project has been completed. Two structures have been identified as potential alternatives for implementing he tapered slot antenna. One of the two structures--the aymmetric slotline has been analyzed rigorously using the Wiener-Hopf theory. Design data for the slot wavelength and the characteristic impedance are being developed.

PUBLICATIONS: R. Janaswamy, "Wiener Hopf Analysis of the Asymmetric Slotline," Submitted for Publication, Radio Science, November 1989.

SIGINT, SIGSEL, OTHT AND C2Cm RESEARCH & REPORT

Stephen Jauregui - Adjunct Professor of E.C.E.
Richard W. Adler - Adjunct Professor of E.C.E.
Department of Electrical & Computer Engineering
Sponsor: SPAWAR 143

OBJECTIVE: Develop and test techniques for passive target location and techniques including HFDF, SSL, Differential Doppler, time difference arrival and Aydrid techniques. In addition develop and test signal acquisition techniques, against a variety of communication signals.

SUMMARY: During the period dates was collected and analyzed on mixed mode HF data for lines of bearing. An examination of new technique verses older acquisition technique for mobile platforms. An examination of intercept techniques for a frequency hopping VHF communication system using simulation techniques. The technique for aircraft tracking using HF signals used field collected data and along with the standard technique applied extended Kalman Filtering.

THESES DIRECTED: D. Galiyas, Capt, USMC, "Determining the Effects of Receiving Sites On Using Differential Doppler To Find Course Track and Speed," MSEE, Dec 89.

E. Hillenbrand, Capt, USA, "An Analyses of Signal Sorting Capability of a VHF Frequency Hopping Intercept, MSEE, Dec 89.

M. Chavez, CAPT, USMC, " Relative Performance Comparison of Combat DF and Classic Outboard Acquisition Systems, MSSE, Sept 89.

R. Hyde, CAPT, USMC, "Performance Analyses of Combat DF Shipboard Direction Finding System, 16 Channel Receiver," MSEE, June 89.

SIGINT, TO NOISE ENHANCEMENT PROGRAM

Stephen Jauregui - Adjunct Professor of E.C.E.
Department of Electrical & Computer Engineering
Sponsor: SPAWAR 144

OBJECTIVE: Measure and investigate sources of noise and interference at high frequency radio receiving sites. Develop mitagation techniques to reduce these sources thus improving the operation capability of these receiving sites.

SUMMARY: Eight different sites were visited during the year to collect noise and interference data. The sources were both external and internal to the site. A number of mitigation techniques have been derived and have been installed at some sites to determine their effectiveness.

THESES DIRECTED: S. Carder, Lt. USN, "HF Switching at HFDF Sited," MSEE, Dec. 89

R. Implellizarri, Lt., USN, "A Dynamic Range Investigation of HF Amplifier," MSEE, Sept 89.

C. Harthcock Maj. USA, "An Analyses of The Enlarger RF System Switching System At Army Field Station," Augsburg, MSSE, Sept 89.

CIRCUIT MODELING FOR MICROWAVE COMPUTER-AIDED-DESIGN

Jeffrey B. Knorr - Professor of E.C.E.
Department of Electrical & Computer Engineering
Sponsor: Naval Ocean Systems Center

OBJECTIVE: To develop CAD compatible circuit models for finline and finline discontinuities such as the inductive strip.

SUMMARY: This project began on 1 Oct 89. A methodology for modeling homogeneous finline and inductive strips in homogeneous finline has been developed. Numerical data derived from spectral domain programs is being used to determine parameter values for equivalent circuit elements. Experiments are being conducted to validate models. The work will be extended eventually to include inhomogeneous finline (finline with dielectric substrate).

THESES DIRECTED: G. Karaminas, "Circuit Models for Inductive Strips in Finline," M. S. Thesis, December 1989.

T. Bush, "An Equivalent Rectangular Waveguide Model for Finline," M. S. Thesis, December 1989.

MODELING OF DIRECT FORCED AIR COOLING OF STANDARD ELECTRONIC MODULES

Allan D. Kraus - Adjunct Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: Naval Weapons Support Center (Code 6042)

OBJECTIVE: Develop a computer code to be used in conjunction with IBM compatible personal computers that will provide a temperature map of the NWSC Form - B Electronic Module.

SUMMARY: A 510 mode model was developed with an easy growth potential to 750 modes. The software developed created a thermal model (conduction only) of the form - B module and this model is filed in the same disk as the thermal analyzer available at NWSC. Inputs consist of component dissipations physical data such as dimensions and thermal conductivities and environmental temperatures. The computer code (model- builder with the thermal analyzer) has been used as a research tool to effect data reduction. Thus, the research performed has resulted in software to be used for verifying current research and evaluating future module designs. It supports specific Navy/DoD Programs such as SHARP, EMSP, BS-1-1 and BS-1-2.

CONFERENCE PRESENTATIONS: A.D. Kraus, et al, "Thermal Advantages of a New Microcircuit Configuration," National Electronic Packaging Conference, Anaheim, CA, 14 Mar 1989.

IMAGE PROCESSING APPLIED TO SENSOR DATA

C.H. Lee, Associate Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: Naval Research Laboratory

OBJECTIVE: Investigate the Graph Partitioning algorithm using a dynamic programming method for track detection. Compare this technique with the conventional techniques in terms of its sensitivity to low power signal in the presence of high power noise.

SUMMARY: Graph Partitioning technique allows an exhaustive search of global optimal arrangement of the detected track. The track could be faint signal trace in a sea of high power background noise. All possible position of the track will be considered in terms of the overall signal to noise ratio in the neighborhood of that position. The main drawback of this technique is the long processing time. In view of readily available computing power at low cost, computation intensive algorithms such as the graph partitioning algorithm could offer high potential for super sensitivity. The initial effort of this new project is concentrated on establishing the processing environment of the graph partitioning algorithm. Large amount of effort is directed toward setting up the test data base. Two data-bases for testing are collected from NRL which are unclassified. Because of the restricted cover range of the databases it may be necessary to supplement the existing data-base with artificial data. Processing results from the initial tests showed very high potential as a valid detection algorithm used in a new system.

PUBLICATION: C.H. Lee, "Affine Invariant Detection of Noisy Object," Proceedings of the International Conference on Image Processing (ICIP' 89), 5-8 September, 1989, Singapore.

CONFERENCE PRESENTATION: C.H. Lee, "Illumination Modeling in 3-D Sonar Images," Sixth Workshop on Multidimensional Signal Processing, September 6-8, 1989, Asiloma CA.

THESIS DIRECTED: Chan-Lon Kao, "Affine Invariant Recognition of Noisy Object," M.S., December 1989.

NAVY ANTI-AIR WARFARE STUDIES

H.-M. Lee - Associate Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: Office of the Chief of Naval Operations

OBJECTIVE: To investigate the effects of ducting and the curvature of Earth on sea clutter up to the vicinity of radar horizon.

SUMMARY: A theoretical framework is being developed so that the propagation of radio waves up to the vicinity of the radar horizon can be accurately and conveniently formulated and solved. This formulation should allow easy extension to include surface roughness of the ocean. The M(ulti)-Layer waveguide propagation program developed by NOSC is been investigated. A thorough update of the documentation of this FORTRAN program including a critical review of its theoretical background is being carried out. This program is being installed at NPS and will be tested against the new theory. Experimentally measured data are needed to evaluate the predictions of the theories. Work has been started to assemble test equipment for propagation and sea clutter data acquisitions.

PUBLICATION: H.-M. Lee, "Propagation in the Presence of a Surface Duct - a New Formulation," in Antennas and EM Theory, Chinese Institute of Electronics and Antenna Society, ed., 285-297, International Academic Publishers - Pergamon Press 1989.

CONFERENCE PRESENTATIONS: H.-M. Lee, "Short Range Propagation Above L Band - A Quasi Cylindrical Approximation," Abstracts of the National Radio Science Meeting, 24, Boulder, Colorado, January 1989.

H.-M. Lee, "Integral Field Representations for the Propagation of Waves Near a Spherical Earth," Proceedings of the 1989 International Symposium on Antennas and Propagation, 449-452, Tokyo, Japan, August 1989.

THESIS DIRECTED: Y.-C. Feng, Major, Taiwanese Army, "CW Projectile Tracking - Range Analysis," Master's Thesis, December 1989.

RAY-MODE COUPLING

H.-M. Lee - Associate Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: Office of Naval Research

OBJECTIVE: To understand the excitation of internal resonant modes of a cavity by an incident plane wave. To extend the formulation to objects of composite materials.

SUMMARY: Analytical results on the scattering of a tubular cylinder of finite length have been obtained by the investigator which compare favorably with experimental data. There are two questions of interests for further studies. One is to investigate the surface current distributions on the cylinder so that the resonant modes can be identified. The other is to extend the current formulation to deal with cases involving objects of composite materials. Programs for the current distribution and the mode coupling coefficients are being edited on the School's main frame computer. Extension of the particular formulation to cases involving composite materials is in progress.

PUBLICATION: H.-M. Lee, "Scattering from a Dielectric Coated Tubular Cylinder," in preparation.

PROJECT GUSTY ORIOLE

H. H. Loomis, Jr.- Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: Space and Naval Warfare Systems Command, SPAWAR 004-54

OBJECTIVE: To conduct research into computer algorithms and architectures for the processing of tactical information. To provide support for the course Space Systems 3001, Military Applications of Space.

SUMMARY: Investigated Algorithms and architectures of systems for the production, distribution and analysis of tactical information. Investigated architectures of spaceborne computer systems. Investigated operational problems concerned with the employment of tactical information for decision making and targeting.

THESES DIRECTED: Melanie Winters, LT USN, "Evaluation of Classic Wizard reporting to Fleet Users and Recommendation for Primary and Secondary Communications Paths," M.S., March 1989.

Graham M. Holmes, LT USN, "Evaluation of Multiple Asset Detection in the Over-The-Horizon Targeting Process," M.S., June 1989.

Herman A. Shelanski, LCDR USN, "Comparison of a Hybrid Space Based Radar with a Monostatic Space Based Radar," M.S., June 1989.

Robert J. Potochney, Jr., LT USN, "Concept of Operations, Architecture, and Implementation of a Small, Tactical Imaging Satellite (U)," M.S., June 1989.

Phillip Gabriel, Capt USMC, "Requirements Determination and Concept of Operations for Multiple System Geolocation (U)," M.S., Sept. 1989.

Ronald C. Repper, LT USN, "OMV Payload Support Concept for Pagasus Boosted Payloads," M.S., September 1989.

Mark A. Wilson, LT USN, "U. S. Navy Tactical Exploitation of a Unique National System," M.S., Sept. 1989.

Alvis Wheatley, Cpt USA, "Use of an Extended Kalman Filter to Enhance Time Difference of Arrival Position Location Systems," M.S., Dec. 1989.

John W. R. Pope, LT USN, "Enhancing Time Difference of Arrival Position Location Systems Using Extended Kalman Filter Methods," M.S., Dec. 1989.

AUTOMATED DESIGN OF VLSI DEVICES FOR NAVY SPACE APPLICATIONS

H. H. Loomis, Jr. - Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: Space and Naval Warfare Systems Command, SPAWAR 004-51

OBJECTIVE: To investigate computer aided design (CAD) techniques for complex VLSI chips to achieve high performance or special functionality.
To provide a vehicle for the evaluation of Application Specific Integrated Circuits (ASICs) to the problems of SPAWAR.

SUMMARY: The Silicon Compiler is a complex item of system software which takes as an input system level descriptions of digital systems.
The output of the software is a detailed layout of a VLSI chip suitable for fabrication in any of a number of possible technologies. The applic ability of a specific Silicon Compiler to the Navy's ASIC needs, in particular in spaceborne systems has been investigated. The tool has also been used to evaluate the effect of different technologies on performance of ASICs. Finally, testing and design-for-test systems and design procedures for VLSI have been developed. Custom chip architectures for portions of a Spaceborne processor being developed for SPAWAR are being designed.

THESES DIRECTED: John Davidson, LT USN, "VLSI Design for Testability in the Genesil Silicon Compiler Environment," M.S., March 1989.

Walter F. Corliss, LT USN, "An Engineering Methodology for Implementing and Testing of VLSI Circuits," M.S., March 1989.

ON-ORBIT ANNEALING OF SATELLITE SOLAR PANELS

Sherif Michael, Associate Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: Space and Naval Warfare Command (SPAWAR)

OBJECTIVE: Investigate the possibility of on-orbit annealing of satellite's InP and GaAs Solar Cells using the new Minority Carriers Annealing Techniques.

SUMMARY: This is a continuation of the ongoing research on Photovoltaic Power Technology. Research tasks include the development and testing of a microprocessor based experiment suitable for small satellites, and incorporating the system proposed in FY 89 research. The tasks also include investigation of Photovoltaic current annealing processes and other related topics of radiation effects on GaAs, InP and Si devices.

CONFERENCE PRESENTATIONS: S. Michael, "On-Orbit Annealing of Satellite Solar Panels," The Interagency Advanced Power Group Workshop, Bendix Aerospace Corp., Alexandria, VA., April 1989.

THESES DIRECTED: R. Sommers, LT, USN, "On-Orbit Annealing of Gallium Arsenide Solar Cell Arrays," M.S., June 1989.

C. Cypranowski, LT, USN, "Power Recovery of Irradiated Gallium Arsenide and Indium Phosphide Solar Cells", M.S., December, 1989.

ENGINEERING DEVELOPMENT AND TEST OF SURFACE AND INTERNAL WAVE TOMOGRAPHY

J. H. Miller - Assistant Professor of E.C.E.
S. Paulsen - Visiting Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: NPS Research Council

OBJECTIVE: This research dealt with ocean acoustic tomography and its application to the study of surface waves and internal waves in the ocean.

SUMMARY: The major accomplishment of the past year's work is the initial data reduction and analyses from a week-long experiment carried out in Monterey Bay in December, 1988. A preliminary analysis of the data from this successful experiment has shown the spectra of the fluctuations in arrival time of acoustic signals is proportional to that of the surface waves. In addition, the experiment was also able to observe fluctuations at wave group frequencies, internal wave frequencies, and tidal frequencies. Analysis is being carried out now on the correlation between surface wave growth and internal wave growth. This work has relevance to the question of viability of tomography in a continental shelf area such as Monterey Bay and the Barents Sea.

PUBLICATIONS: J.H. Miller, J.F. Lynch, and C.S. Chiu, "Observations of Acoustic Travel Time Fluctuations at Surface Wave Frequencies," Journal of the Acoustical Society of America, in progress.

J.F. Lynch, J.H. Miller and C.S. Chiu, "Observations of Acoustic Travel Time Fluctuations at Internal Wave and Tidal Frequencies," Journal of the Acoustical Society of America, in progress.

R.C. Dees, J.H. Miller, K.P. Schaaff, S. Paulsen, C.S. Chiu, L.L. Ehret and J.F. Lynch, "Signal Processing in the 1988 Monterey Bay Acoustic Tomography Experiment," Proceedings of the 18th International Symposium on Acoustical Imaging, Forthcoming.

J.H. Miller, J.F. Lynch, and C.S. Chiu, "Estimation of sea surface spectra using acoustic tomography," Journal of the Acoustical Society of America, 86(1), 326-345, (1989).

J.F. Lynch, J.H. Miller, and C.S. Chiu, "Phase and travel time variability of adiabatic acoustic normal modes due to scattering from a rough sea surface, with application to shallow water, and high latitude regions," Journal of the Acoustical Society of America, 85(1), 83-89, (1989).

CONFERENCE PRESENTATIONS: R.C. Dees, J.H. Miller, K.P. Schaaff, S. Paulsen, C.S. Chiu, L.L. Ehret and J.F. Lynch, " Signal Processing in the 1988 Monterey Bay Acoustic Tomography Experiment," 18th International Symposium on Acoustical Imaging, Santa Barbara, CA, September 18-20, 1989.

J.H. Miller, J.F. Lynch, and C.S. Chiu, "Preliminary results of the 1988 Monterey Bay acoustic tomography experiment," 117th Meeting of the Acoustical Society of America, Syracuse, May 22-26, 1989.

THESES DIRECTED: C.C. Kao, LT, Taiwan Navy, "The Sensitivity of the Stochastic Acoustic Tomography Estimate to the Uncertainties in the Sound Speed Field Covariance," .M.S., December 1989, Co-advised with C.S. Chiu.

K.P. Schaaff, LT, USN, "Monterey Bay Acoustic Tomography: Signal Processing Using Multi-Channel Data Synchronized Quadrature Phase Demodulation," M.S., September 1989.

R.C. Dees, LT, USN, "Signal Processing and Preliminary Results the 1989 Monterey Bay Acoustic Tomography," M.S., June 1989.

PATENT APPLICATION: "Data-synchronized quadrature phase demodulator," Submitted for application by the Navy, September 1989.

THE VIABILITY OF ACOUSTIC TOMOGRAPHY IN MONITORING THE CIRCULATION OF MONTEREY BAY

J.H. Miller - Assistant Professor of E.C.E.
L.L. Ehret - Adjunct Research Instructor of E.C.E.
L.J. Ziomek - Associate Professor of E.C.E.
Department of Electrical and Computer Engineering
T.P. Stanton - Adjunct Research Professor of Oceanography
E.J. Thornton - Professor of Oceanography
Department of Oceanography
Sponsor: Monterey Bay Aquarium Research Institute

OBJECTIVE: This research dealt with the question of the viability of a permanent ocean acoustic tomography monitoring system for Monterey Bay.

SUMMARY: The basis for ocean acoustic tomography is the measurement of travel times of coded acoustic signals between the transceivers. The sound speed field and current structure can be inferred from the fluctuations in the travel times. However, the extreme bathymetry of the Monterey Submarine Canyon complicates the acoustic transmissions in the Bay. The study consisted of an experiment and a computer modeling effort. The experiment consisted of transmitting tomography signals in the Bay for four days. The signals were received with a sonobuoy-based telemetry system. The experimental effort showed multipath arrivals that were stable and resolvable. The modeling effort involved the use of 2-D and 3-D ray tracing computer programs. The programs had difficulty in modeling the effects of Monterey Bay's extreme bathymetry making the multipath identification challenging. Progress is expected with the augmentation of the ray tracing programs with Gaussian beam and time front postprocessors.

PUBLICATIONS: J.H. Miller and P.J. Lynch, "Gold code phase modulation in ocean acoustic tomography," Journal of Oceanic Engineering, in progress.

J.H. Miller, L.L. Ehret, R.C. Dees and T.R. Rowan, "The Viability of Acoustic Tomography in Monitoring the Circulation of Monterey Bay," Naval Postgraduate School Technical Report NPS62-89-003. December, 1989.

CONFERENCE PRESENTATIONS: J.H. Miller, L.L. Ehret, C.S. Chiu, and J.F. Lynch, "The Viability of Acoustic Tomography in Monitoring the Circulation of Monterey Bay," accepted by American Geophysical Union 1990 Ocean Sciences Meeting, New Orleans, Forthcoming.

D.D. Pierce, C.W. Therrien, and J.H. Miller, "Matched Field Processing for Underwater Source Localization," Sixth Institute of Electrical and Electrical Engineers - Acoustics, Speech, and Signal Processing Workshop on Multidimensional Processing, Monterey, CA, September 6-8, 1989.

F.M. Strohm, J.H. Miller, and R.H. Bourke, "A Simulation of Ocean Acoustic Tomography using Matched Field Processing," Sixth Institute of Electrical and Electrical Engineers - Acoustics, Speech, and Signal Processing Workshop on Multidimensional Processing, Monterey, CA, September 6-8, 1989.

THESES DIRECTED: D.D. Pierce, LT, USN, "Underwater Source Localization with Matched Field Processing," M. T., December 1989, Co-advised with C.W. Therrien.

R.C. Scott, CAPT, Canadian AF, "Parallel Processor Based Gaussian Beam Tracer for Use in Ocean Acoustic Tomography", M.S., December 1989.

P.J. Lynch, LT, USN, "Computer Simulation of Gold Code Phase Modulation in Ocean Acoustic Tomography," M.S., June 1989.

F.M. Strohm, LCDR, French Navy, "Simulation of Ocean Acoustic Tomography using Matched Field Processing," M.S., June, 1989. Co-advised with R.H. Bourke.

RESEARCH IN DIGITAL SIGNAL PROCESSING: COMMUNICATIONS DIGITAL SIGNAL PROCESSING

Paul H. Moose - Associate Professor of E.C.E.
Spomsor: NOSC, Mr. Darrell Marsh; Direct Funding

OBJECTIVE: To develop a high data rate packet communication technique and to identify the limiting channel parameters of an acoustic link for a critical Naval application.

SUMMARY: Conventional computer-to-computer communications links employ external modems, and band-shifters to interface the computers to the physical link. In this research, we have developed a technique to encode signal packets in the frequency domain and generate directly in the time domain bandpass signals using an inverse FFT embedded within the host computer. The computer receiving the packets performs the inverse operation for decoding and error correction. Redundancy in either time or frequency, to provide jam resistance and/or error control coding are introduced very simply in the software driven encoding process.

The application for this technique, known as Multi-Frequency Modulation (MFM), a near vertical acoustic link. Initial field tests to gather channel data beqan in 1989. Real time hardware has been developed using PC/AT personal computers as hosts has been developed and is operating in the laboratory thru a simulated acoustic channel.

PUBLICATIONS: Paul H. Moose, "Theory of Multi-Frequency Modulation," NPS62-89 019, March 1989.

THESES DIRECTED: T. K. Gantenbein, "Implementation of Multi-Frequency Modulation on an Industry Standard Computer," M.S., Sept. 1989

Anita S. Daniel, "Simulation of Acoustic Communications Channels," M.S. (EE), Sept. 1989

PATENT APPLICATION: "Multi-Frequency Quadrature Phase Shift Keyed MODEM," Disclosed on 2 August 1989.

SYNCHRONIZATION OF 2FSK/QPSK DEMODULATORS

Glen A. Myers, Associate Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: Space & Naval Warfare Systems Command

OBJECTIVE: To investigate means of synchronizing 2FSK/QPSK demodulators.

SUMMARY: The effect of FM jamming on a phase-locked loop (PLL) used as a tracking narrowband filter was investigated. Computer simulations of FM capture effect were conducted. A laboratory hardware system was designed, built and tested to verify the computer results and to obtain data on the performance of the PLL.

THESES DIRECTED: Soon-Sang Park, "On the Capture Effect of FM Demodulators," M.S., March 1989

Dennis G. Bevington, "Measurement of the Capture Effect of Frequency Modulation," M.S., December 1989.

TARGET IDENTIFICATION USING RESONANCE ANNIHILATION FILTERING

Michael A. Morgan - Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: DARPA Tactical Technology Office

OBJECTIVE: Investigate new signal processing and filtering methods for the identification of radar targets using aspect-independent complex resonances.

SUMMARY: Target Identification using annihilation filtering of natural resonances is continued to be investigated. Two new signal processing algorithms were considered for estimation of resonances in noisy radar scattering data. Target pole invariance to aspect was demonstrated for metallic scale model tactical aircraft. The transient scattering range in Sp-535 has been upgraded using new measurement devices and computational equipment. New control, acquisition and signal processing software has also been designed.

PUBLICATION: M.A. Morgan, P.J. Moser and H. Uberall, "Finite Element Computation of Complex Resonant Frequencies for Penetrable Axisymmetric Bodies," Journal of Electromagnetic Waves and Applications, 3 (2), March 1989.

CONFERENCE PRESENTATIONS: M.A. Morgan, "Transient Scattering Measurements," Workshop on the Singularity Expansion Method, University of Alabama, 27-28 August 1989.

M.A. Morgan, "SEM and the Early Time," Invited Workshop on the Singularity Expansion Method, University of Alabama, 27-28 August 1989.

THESES DIRECTED: M.S. Simon, LT, USN, "A Comparison of the K-Pulse and E-Pulse Techniques for Aspect Independent Radar Target Identification," M.S Thesis, September 1989.

P.D. Larison, CAPT, USMC, "Evaluation of System Identification Algorithms for Aspect Independent Radar Target Classification," M.S. Thesis, December 1989.

N.J. Walsh, MAJ, Canadian Forces, "Bandwidth and SNR Enhancement of the NPS Transient EM Scattering Range," M.S. Thesis, December 1989.

COMPUTER AIDED DESIGN OF NAVY MISSILE RADOMES

Michael A. Morgan - Professor of E.C.E.
Rama Janaswamy - Assistant Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: Naval Weapons Center, China Lake

OBJECTIVE: Develop and validate finite element based computer algorithms for the analysis of antenna pattern changes due to inhomogeneous layered missile radomes.

SUMMARY: A powerful new finite element computer program is being developed and validated which allows accurate analysis of the penetration of incident EM fields through a complex layered radome, as defined by the user. The particular use is for Navy missile seeker antennas which are covered by an aerodynamic radome. Such missiles are highly susceptible to boresight tracking errors induced by aberations in the antenna pattern caused by the radome. A new class of missile radomes, constructed from inhomogeneous materials is being considered for future use. The work here will allow the efficient designs for such radomes, with a minimum of cut and try.

PUBLICATIONS: M.A. Morgan, Ed,"Differential Equation Based Numerical Methods in Electromagnetics," Special Issue of the Journal of Electromagnetic Waves and Applications, 3 March 1989.

M.A. Morgan, Finite Element and Finite Difference Methods in Electromagnetic Scattering, Elsevier Science Publishing Co., 1989.

THESES DIRECTED: T.B. Welch, LT, USN, "EM Scattering from Two-Dimensional Objects Using the Field Feedback Formulation," Master's and Engineers Thesis, March 1989.

R.J. Vince, LT, USN, "An Electromagnetic Radome Model Using an Interactive Computer Finite Element Algorithm," M.S. Thesis, December 1989.

PROPAGATION OF SCALAR ACOUSTIC WAVES

John P. Powers - Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: Office of Naval Research

OBJECTIVE: To apply spatial frequency domain techniques to modeling the propagation of pulsed and transient ultrasound waves in lossless and lossy media. The technique would allow the application of computer-efficient FFT algorithms to problems that have previously used complicated line integrals for evaluation.

SUMMARY: Work continues to apply the spatial transform approach to lossy media. Models for media with a quadratic dependence of the attenuation coefficient fit the Stoke's equation. Work began on modeling low-diffraction waves. Theoretical efforts by others show that certain mathematical waveforms will have lower diffraction than commonly occurring waves. For example, the diffraction of a Bessel function Jo(r)/r is smaller than a gaussian-shaped wave. Modeling has begun using Matlab, Mathematica, and Fortran algorithms.

SOLID PROPELLANT COMBUSTION/AUTOMATED DATA RETRIEVAL FROM HOLOGRAMS

David Netzer - Professor of Aeronautics
Department of Aeronautics
John P. Powers - Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: Air Force Rocket Astronautical Laboratory

OBJECTIVE: To develop techniques to obtain particle size data within the combustor and across the exhaust nozzle of solid propellant rocket motors.

SUMMARY: This continuing investigation consists of two main studies: (1) experimentally measuring particulate sizes using measurements of forward scattered light, holography, high speed motion pictures and SEM evaluation of residue collected in an exhaust probe; and (2) development of techniques for computer-aided automatic retrieval of particle size data from holograms. The former effort is summarized in the report from Professor D.W. Netzer. Feature identification and counting was speeded up through the reprogramming of our algorithms into the C language. Speed improvements continue to be achieved as the code is optimized. Additionally, less fragmentation of the programs is required. Memory limitations imposed by DOS in the Fortran programs limited some processing to partial images. These memory limitations were removed by the dynamic memory allocation techniques that C allows. Additionally the processing had to be done with sequential Fortran programs due to limited memory. Now all operations are done in one program on full screen images under menu control.

PUBLICATIONS: "Measurement of particulates in solid propellant motors", Proceedings of the 24th JANNAF Solid Combustion Meeting, Vol. 1, CPIA Pub. 498, Chemical Propulsion Information Agency, Johns Hopkins University, pp. 155-174

THESES DIRECTED: Particle sizing in rocket motor holograms using a C language program, LT Valerie Hochgraver, USN, M.S., Sept. 1989

UNDER WATER FIBER OPTIC COMMUNICATIONS

John P. Powers - Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: Space and Naval Warfare Systems Command

OBJECTIVE: To study the use of fiber optic cables for transmitting the data. This report is on the fiber optic telemetry portion of this project.

SUMMARY: Design efforts continued on a multi-channel fiber optic data link from undersea experiments to shore. Three approaches were investigated. The first is an analog link using FM optical carrier modulation to allow multiple analog channels to be frequency division multiplexed and transmitted over the fiber. A set of active filters separate and detect the channels. (Active filters using commercial components have been designed and test up to 10 MHz operating frequencies, for the first time.) The second approach uses a high-speed A/D converter to digitize the data. A microprocessor controls the digitization, time-domain multiplexing, and frame synchronization. The clock-encoded data stream is received and demodulated at the receiving end. The third approach studied the use of code division multiplexing to all several channels of information to be transmitted simultaneously.

THESES DIRECTED: R. Heuler, CAPT, USA, "Study of Inter-Computer Data Transmission Using Simultaneous Time-Domain Multiplexing and Wavelength-Division Multiplexing," M.S., June 1989.

Steven Larson, LCDR, USN, "High-Speed VLSI Architectures for Use with Laser Data Transmission Buses," M.S, June 1989.

M. Anderson, LT, USN, "A Local Area Network Using a Fiber Optic Data Bus," M.S., Sept 1989.

Scott Sundt, LT, USN, "Implementation of a Code Division Multiple Access Transmitter/Receiver Scheme Utilizing a Fiber Optic Medium," M.S, Dec 1989

Ilias Dimopoulos, LT, Hellenic Navy, "RF Frequency-Division Multiplexing on a Fiber Optics Communications Link," M.S., Dec 1989

CORRECT PACKET CAPTURE IN MOBILE DATA COMMUNICATIONS WITH CONVOLUTIONAL CODING

R. Clark Robertson - Associate Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: NPS Research Council

OBJECTIVE: The goal of this project is to determine the capabilities of the pseudo-Bayesian slotted Aloha system for mobile communications applications.

SUMMARY: The throughput and average packet delay for the slotted Aloha random multiple access protocol are different for mobile communications applications. Specifically, the effects of multipath and the near/far effect combine to improve the average probability of correctly capturing a data packet which in turn significantly changes throughput and packet delay. The objective of this project is to evaluate the slotted Aloha protocol for the mobile communications environment. First, the probability of correct packet capture when multipath and the near/far effect are accounted for will be determined. Next, the use of spatial diversity and convolutional coding with hard decision Viterbi decoding will be examined to determine the extent to which the probalility of correct packet capture can be improved. Finally, the associated throughput and average packet delay will be found.

IMAGE ENHANCEMENT OF UNDERWATER OBJECTS

Charles W. Therrien, Professor of E.C.E.
Roberto Cristi, Associate Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: Naval Undersea Warfare Engineering Station

OBJECTIVE: Objectives of this project were to develop a system for enhancement of images during underwater recovery operations. The system would use a combination of real-time and non real-time methods.

SUMMARY: An image processing system based on an IBM or IBM compatible microcomputer was developed and applied to the problem of underwater viewing. The system uses framegrabber hardware that plugs into the microcomputer bus and refreshes a small video display. The system uses a combination of hardware and software (custom programs developed at NPS and commercially produced programs) to perform the image enhancement. The system was tested at sea during a recovery mission. Recently a menu interface was added to the system which can be activated either from the keyboard or with a mouse.

PUBLICATION: C.W. Therrien and W.J. Partridge, "Image Enhancement Software for Underwater Recovery Operations - User's Manual," Technical Report NPS62-89-023, Naval Postgraduate School, June 1989.

THESES DIRECTED: W.J. Partridge, "Real Time Image Enhancement During Underwater Recovery Operations", M.S., June 1989.

ADAPTIVE AND MARKOV MODEL METHODS FOR SIGNAL PROCESSING

Charles W. Therrien, Professor of E.C.E.
Murali Tummala, Assistant Professor of E.C.E.
Roberto Cristi, Associate Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: Office of Naval Research

OBJECTIVE: Objective of this research were to investigate techniques for adaptive filtering and modeling of one-dimensional and multidimensional signals.

SUMMARY: The research focused on development of structures and algorithms for modeling and filtering one- and two-dimensional signals. Some new 2-D adaptive algorithms were developed and applied to noise removal and coding in images. Some new iterative algorithms were investigated for 2-D spectral estimation in particular and the solution of block-Toeplitz matrices in general.

The work also explored methods based on Markov models for 1-D and 2-D signals. This included the application of Markov methods to acoustic transient modeling in 1-D and to image segmentation in 2-D.

THESIS DIRECTED: A. M. Sequeira, "Adaptive Two-Dimensional RLS Algorithms," Engineer's Degree, 1989.

LANCZOZ ALGORITHMS FOR SPECTRAL ESTIMATION AND DETECTION FINDING PROBLEMS

Charles W. Therrien, Professor of E.C.E.
M. Tummala, Assistant Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: NOSC, San Diego, CA

OBJECTIVE: The objective of this research is to develop iterative methods for subspace-based direction finding algoritms. Lanczos iterative algorithms are explored in particular.

SUMMARY: The work involved the development of single vector, block and selective orthogonalization algorithms of the Lanczos method. These algorithms are useful in applications where we need to estimate only a few of the extreme eigenvalues. This results in considerable computational savings. Particular applications of interest to us are high resolution spectral analysis and estimation of the direction-of-arrival of point sources in low signal-to-noise ratio environments. The Lanczos algorithms fall under the class of problems called subspace methods. The single vector algorithm has been thoroughly investigated in this work. The results indicate that the eigenvectors found using the algorithm can be used to determine spectral peaks at signal-to-noise ratios as low as -5 dB. A technique called spectral product has been used to enhance the performance of the algorithm. The block algorithm is amenable to signals whose autocorrelation matrix has multiple extreme eigenvalues. Note that this assumption is applicable to problems where the spectral peaks are present in wideband noise, i.e., in white or nearly white additve noise. The performance of the block algorithm has been enhanced by using the spectral product technique as in the single vector case. In our results we have observed that the block method has consistently performed better than or same as the single vector algorithm in low signal-to-noise cases.

THESES DIRECTED: D.E. Gear, "Direction of Arrival Estimation by Eigendecomposition Using Single Vector Lanczos Algorithm," M.S., June 1989.

Y.-J. Kim, "Block Lanczos Algorithm," M.S., December 1989.

CROSSBOW COMMITTEE

Harold A. Titus - Professor of E.C.E.
Department of Electrical & Computer Engineering
Sponsor: U.S. Army Missile & Space Intel Center

OBJECTIVE: Investigate designated Soviet missiles and missile radars. Simulate the above and evaluate industry proposals for developing look-alike models of the Soviet systems covering the range from software to hardware copies. Participate in workshops and I-Teams (specific missile subsystem intelligence groups) to develop effective and least cost models that industry will produce for the three Services.

SUMMARY: A Soviet Missile has been simulated in coordination with engineers at MSIC, Redstone Arsenal, Al. The thesis by Cockerham covered this development. Several Crossbow Meetings and Antenna Workshops have been hosted here at NPS. In addition, a group of students and faculty (Cockerham, Bauer, Powell, Burl, Bouldry, and Wilson) have been involved in these deliberations and several point papers have been presented. We are presently involved with the antenna workshop group, and SA-17 I-teams in missile and search and tracking radar subsystems, missile guidance subsystem, and fire control and signal processing subsystems.

CONFERENCE PRESENTATION: J. Powell, H. Titus, "Antenna Array Riplication Requirements," August 23, 1989.

THESES DIRECTED: K. Cockerham, "The Effect of Autopilot Configuration on Missile Response."

ATTITUDE CONTROL & TRACKING PROBLEMS FOR SPACE SYSTEMS

Harold A. Titus - Professor of E.C.E.
Department of Electrical & Computer Engineering
Sponsor: Space & Naval Warfare Systems Command

OBJECTIVE: To design optimal control configurations for the Orion Spacecraft. To develop target tracking algorithms for space systems.

SUMMARY: Without a specific payload for Orion, it was necessary to design control configurations for various possibilities (spin stabilized, gravity gradient, gas jet,...). Dee, Boyd and Cunningham have addressed these problems. The tactical utilization of space systems for target tracking was addressed by Wheatley and Pope.

CONFERENCE PRESENTATIONS: S. Dee, J. Cunningham, H. Titus, "Optimal Attitude Control for Spacecraft-Pontryagin Revisited," IEEE International Controls Conference, Isreal, April 1989.

THESES DIRECTED: J. Cunningham, "Optimal Attitude Control for Orion," M.S., March, 1989.

J. Pope, "Space Based Tracking," M.S., September, 1989.

A. Wheatley, "Tactical Tracking from Space," M.Ss, September, 1989.

CHAFF

Harold A. Titus - Professor of E.C.E.
Department of Electrical & Computer Engineering
Sponsor: Naval Sea Systems Command

OBJECTIVE: Investigate optimal methods of chaff placement and ship maneuver for ship defense against ASCM.

SUMMARY: Chaff has been around for a long time. Yet, the fathers of chaff lost their largest ship in the Falklands due to its misuse. Computer simulation programs were developed to simulate the ship's defense against the cruise missile. Two quite different techniques were developed by Siddiq and Taborda for their respective Navies and in different computer languages. The basic idea is to cause the missile to break lock in range gate and/or angle gate. The geometry of the encounter is critical, as is also the type of missile and type of chaff launcher.

THESES DIRECTED: Siddiq, "Optimal Chaff Placement and Ship Maneuvers," M.S., September 1989.

Taborda, "Training Simulations in C-Language for ASCM Defense," M.S., September 1989.

TORPEDO TRACKING

H. Titus - Professor of Electrical & Computer Engineering
Sponsor: Naval Undersea Warfare Engineering Center

OBJECTIVE: Application of Smoothing algorithms to the Kalman Filter tracking of torpedoes.

SUMMARY: Our torpedoes are tracked by acoustic arrays located in a grid on the ocean bottom. There are problems associated with passing the torpedo track from array to array, maneuvers, and signal dropout. A smoothing algorithm was added to a Kalman Filter tracking program to alleviate these problems. The work by Nicklas proved quite effective.

CONFERENCE PRESENTATIONS: R. Nicklas, F. Webb, H. Titus, "Applications of Kalman Filtering to Naval Problems," IEEE, International Controls Conference, Isreal, April, 1989.

THESES DIRECTED: R. Nicklas, "Torpedo Tracking and Smoothing Algorithms," March, 1989.

ANALYSIS OF RAPID TRANSEARTH TRAJECTORIES FOR LUNAR LAUNCH SITES

D.v.Z. Wadsworth - Adjunct Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: NPS Research Foundation

OBJECTIVE: Develop a computer simulation for synthesizing earth moon trajectories in support of a lunar base. determine flight-time vs. energy trades and guidance sensitities for a class of transearth trajectories, utilizing the above simulation.

SUMMARY: During the spring quarter '89, I was sponsored by the Foundation as PI for the above project. The remaining task, planned to result in a paper to be submitted during the winter quarter '90, is to perform the flight-time vs. energy trades and guidance sensitivities, utilizing the simulation.
In connection with reading courses, two students were involved in developing the trajectory simulation, using the Mac SE/30 purchased with the research funds.

THESIS DIRECTED: L.S. Hiponia, LT, "The Critical Path Required for Establishing A Moon Base," M.S., Sept, 89.

TIMING VERIFICATIONS FOR VLSI DESIGNS

C. Yang - Assistant Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: NPS Research Council

OBJECTIVE: To design a CAD tool to assist the digital designers in rapidly performing the timing verification at the prototyping stage. To explore the parallel processing benefit and its applicability to the design verification.

SUMMARY: This project is started October 1988 and is done in September 1989. However, due to lack of sufficient well-trained C programmers while this project first started I did not explore the pruning techniques. The plan was to develop circuit recognition algorithms before any pruning technique can be adopted. We accomplished the task of recognizing inverters, pass gates, and unnamed level one components (see below, Joe Swisher's thesis). Emmanouil Zagourakis extended Swisher's work for more named structures and his expected graduation is in March 1990. I spent at least four hours with Swisher and Zagourakis each week. The results from this research can provide design verification, not timing, in structures or topology. Any DoD related VLSI design can use the programs developed by this reaserch. On the other hand, two students out of my EC4820 class (computer architecture) were inspired by the parallel processing ideas: Johnson and Scott. First, we validated the conjecture on the relationship between the performance and the workfarm topologies. Addressed mode workfarm outperformed the linear model with less survivalbility. Communication costs may be higher in smaller work packets. Due to Scott's double degree requirements he chose the ocean acoustic as an application area instead the VLSI.

PUBLICATIONS: C. Yang and T. Johnson, "A Sensitivity Analysis of Linear Workfarm Model," Paper accepted for a poster presentation at SIAM Conference on Parallel Processing in Scientific Computing, Chicago, December 1989.

C. Yang, T. Johnson, and R. Scott, "A Study of two Workfarm Topologies," Draft submitted to Annual Symposium on Parallel Processing.

THESES DIRECTED: J. Swisher, CPT, USA, "Circuit Recognition of VLSI Layouts," M.S., September 1989.

T. Johnson, LT, USN, "Analysis of Transputer-Based Workfarm Topologies," M.S., September 1989.

Rod Scott, CPT, Candian Airforce, "Parallel Processor Based Gaussian Beam Tracer for Use in Ocean Acoustic Tomography," M.S., December 1989.

VLSI DESIGN FOR SPACEBORNE APPLICATIONS

C. Yang - Assistant Professor of E.C.E.
H.H. Loomis - Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: Naval Research Laboratory

OBJECTIVE: Investigate silicon compiler techniques and design for test methods for the design of complex spaceborne digital processors in Navy applications.

SUMMARY: A first attempt of using silicon compiler in designing notch filters produced numerous experimental results. The notch filters were designed as pipelined processors and the timing of pipeline stages were studied. We used fixed point computations and explored all possible ways to build the basic block: sign-magnitude, one's and two's complement. We added master-slave flip-flops into each building block. Each basic block consists of a pipelined multiplier and a pipelined adder. The notch filter design is a important spaceborne application and is vital to the DoD and Navy. Several on board processor related subjects have been closely investigated and will be implemented by using silicon compiler in 1990.

ON THE USE OF MULTIPLE-VALUED LOGIC IN THE DESIGN OF DIGITAL SYSTEMS

C. Yang - Assistant Professor of E.C.E.
J.T. Butler - Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: Naval Research Laboratory

OBJECTIVE: To investigate heuristic minimization algorithms for multiple-valued logic and MVL programmable logic arrays.

SUMMARY: Several heuristic methods have been proposed for multiple-valued logic minimization. However, most of them were developed by examining some special cases. A fundamental improvement of known heuristic minimization methods was devised and named Neighborhood Decoupling (ND) Algorithm. The ND-algorithm selects the most isolated minterm and most isolated implicant during the minimization process. This algorithm outperforms others both in computation time (shorter) and output terms (fewer). I coined the term "neighborhood decoupling" and my thesis student Y. M. Wang helped me in implementing it in C programming language. The program was written as one independent extension to the software tools, HAMLET, that concurrently developed by professor Butler and a instructor in CS department (Yurchak).

PUBLICATION: C. Yang and Y. M. Wang, "A Neighborhood Decoupling Algorithm for Truncated Sum Minimization," {International Symposium on Multiple-Valued Logic}, Forthcoming.

THESIS DIRECTED: Y. M. Wang, CPT, Taiwan, "Truncated Sum MVL Minimization Using the Neighborhood Decoupling Algorithm," M.S., December 1989.

UNDERWATER ACOUSTIC PROPAGATION AND SCATTERING IN A RANDOM OCEAN-A LINEAR SYSTEMS THEORY APPROACH

Lawrence J. Ziomek - Associate Professor of E.C.E.
Department of Electrical and Computer Engineering
Sponsor: Office of Naval Research (Dr. Marshall Orr)

OBJECTIVE: Continuation of the development of both a mathematical and a numerical ocean acoustic pulse-propagation model based on the principles of linear, time-variant, space-variant, random filter theory and the physics of wave propagation in random media.

SUMMARY: A full-wave, pulse-propagation model for three-dimensional wave propagation in a Pekeris waveguide based on linear systems theory is under continued development and generalization. The randomly rough ocean surface and bottom are accounted for via coherent (average) reflection coefficients. Attenuation due to absorption in all three fluid media is included. Transmit and receive planar arrays with beam steering can be simulated and, as a result, vertical arrays and a single, omnidirectional point source are automatically included. A built in signal generator can simulate arbitrary amplitude and angle modulated carriers. Outputs from this model include plots of the magnitude and phase of the ocean surface and bottom reflection coefficients and the complex acoustic field across the receive array as a function of frequency, and the time-domain pulse(s) at the receive array. Because of its highly modular structure, the model can also be used to generate pulse-propagation solutions using any time-harmonic solution such as normal mode theory or the parabolic equation method.

PUBLICATIONS: L. J. Ziomek, "Three-Dimensional Ray Acoustics: New Expressions for the Amplitude, Eikonal, and Phase Functions," IEEE J. Oceanic Engineering, Vol. 14, 396-399 (1989).

L. J. Ziomek, "A Linear Systems Theory Approach to the Solution of the Linear Wave Equation with Arbitrary Source Distribution in an Unbounded Isospeed Medium," in review, J. Acoustical Society of America.

CONFERENCE PRESENTATIONS: L. J. Ziomek, L. A. Souza, and P. R. Campbell, "Pulse Propagation In a Random Ocean - A Linear Systems Theory Approach," OCEANS '89, 1211-1216, September 18-21, 1989, Seattle, Washington.

THESES DIRECTED: L. A. L. de Souza, "A Linear Systems Theory Approach to the Range-Independent Acoustic Channel," M.S., June 1989.

P. R. M. Campbell, "An Ocean Medium Pulse Propagation Model Based on Linear Systems Theory and the WKB Approximation," M.S., June 1989.

M. P. Markopoulos, "Numerical Pulse Propagation Studies Using Two Classical Ocean Waveguide Models," M.S., December 1989.

DEPARTMENT
OF
MATHEMATICS

DEPARTMENT OF MATHEMATICS

The research program of the Mathematics Department seeks to advance the state of knowledge in areas important to the Department of the Navy and Department of Defense, such as fluid flow, weather prediction, orbital mechanics, and communications.

The specific research areas of our faculty and their students are reported in detail, including sponsors, later is this book. Output appears in the form of student theses, technical reports, conference presentations, and refereed journal articles.

SCIENTIFIC COMPUTATION

The area of scientific computation includes both numerical and analytical (symbolic) solution to a variety of problems of interest to the Department of the Navy and Department of Defense. Research has been conducted by Professor Danielson and several students to obtain analytical solutions to the equations of motion of a satellite orbiting an oblate planet. The complexity of the algebraic manipulations was eased by the use of MACSYMA on the Vax computer (ECE department). Another PC software program (MATHEMATICA) was employed by Professor Canright in his research. His studies were in the area of fluid dynamics.

Professors Neta and Schoenstadt are working with Professor R.T. Williams of Meteorology on the development of finite element schemes for weather prediction. This research is now evolving into development of solutions of such problems on a Hypercube, a parallel computer having (in our case) 8 processors, each working simultaneously and independently on different parts of a problem.

Professor Gragg is working on techniques for fast evaluation of eigenvalues and factorization of matrices. His work includes the use of PC MATLAB. His goal is to develop more efficient codes for these computations.

Professor Russak is working with Professor Goldstein from the University of Washington to develop methods for the minimization of "noisy" functions, that is, functions known only subject to errors.

Professor Franke has continued his work on scattered data approximation especially with application to meteorological data.

Professor Scandrett has continued his work on scattering from submerged structures. He also worked with Professor Canright and Professor Baker of Physics on applications of the T-matrix method to low frequency active array performance prediction. The objective of this work is to produce a robust method to predict the performance of a low frequency active sonar array.

Professor Frenzen has studied error bounds for asymptotic expansions of special functions.

MATHEMATICAL MODELING

Professor Jayachandran has continued working with Professor Larson of Operations Research using statistical analysis to monitor wear conditions of critical military equipment. This work has been sponsored by Kelly Air Force Base and is helping the Air Force keep their planes in the air a greater proportion of the time.

Professor Schoenstadt is working with Professor Parry of Operations Research on an Airland Research Model for the U.S. Army TRADOC Analysis Center. The model is a methodology development to consider models for land combat at the Division and Corps levels.

Professor Danielson has been working on development of a mathematical model for buckling of stiffened plates which are important components of ships and submarines. His methods will improve the construction of these vessels.

DISCRETE MATHEMATICS/COMMUNICATIONS

Professor Fredricksen has been working on development of a stream cipher coding/cryptography system analogous to the block coding system of classical design.

Professor Kim Hefner is applying graph theory to communication networks for channel assignments. She is also developing an algorithm which will decompose a large network into smaller subnetworks. This will facilitate making frequency assignment in polynomial time.

APPLICATION OF THE T-MATRIX METHOD TO LOW-FREQUENCY ACTIVE ARRAY PERFORMANCE PREDICTION

S.R. Baker, Assistant Professor of Physics
D.R. Canright, Assistant Professor of Mathematics
C.L. Scandrett, Assistant Professor of Mathematics
Sponsor: Anti-Submarine Warfare Group

OBJECTIVE: Produce a computationally efficient, accurate model of low-frequency active sonar array performance.

SUMMARY: Our approach is to split the problem into two: a finite-element model for the sonar transducers, and an analytic model of the acoustic field (including all the acoustic interactions by the T-Matrix Method). The first stage of this work has been completed; Professors Canright and Scandrett have jointly developed a general computer program that implements the analytic acoustic model for any array geometry, characterizing the interactions as an impedance matrix. This code has been tested and verified by comparison with published results. Work on the finite-element transducer model, and coupling the two models, is currently underway.

THESIS DIRECTED: LT McLean has begun work on applying the finite-element code "ATTILA" to the modeling of a spherical sonar transducer. Her expected graduation date is June 1990.

BUOYANT CONVECTION EFFECTS IN DENDRITE GROWTH

D.R. Canright, Assistant Professor of Mathematics
Sponsor: NPS Research Council

OBJECTIVE: Analyze the effects of buoyantly driven flow on the solidification of a dendrite of pure material, e.g., metals.

SUMMARY: Solidification processes occur frequently in materials processing, and the details of the process affect the microstructure, and hence the bulk properties, of the final product. This work analyzes how gravity affects the process through buoyant flow in the melt. The results may be useful in deciding when to process materials in a micro-gravity environment. The analytical approach taken here is particularly suited to exploring the dependence on the parameters of the problem. This work is complete, and an article is in preparation.

CONFERENCE PRESENTATION: D. Canright and S.H. Davis, "Buoyant Convection Near A Solidifying Paraboloid," Annual Meeting of the Society for Industrial and Applied Mathematics, San Diego, CA, 17-21 July 1989.

DEVELOPMENT AND VERIFICATION OF MATHEMATICAL FORMULAS FOR THE ORBITS OF EARTH SATELLITES

D.A. Danielson, Associate Professor of Mathematics
Sponsor: Naval Surface Weapons Center

OBJECTIVE: Develop mathematical formulas for the orbits of artificial satellites, useful for rapid calculation of orbits.

SUMMARY: An analytical solution is found to the equations of motion of a satellite orbiting an oblate planet. The method is based upon perturbation technique known as the method of strained coordinates. The formulas include the effect of the J2 terms in the planet's geopotential, and are free of singularities for all parameters.

PUBLICATION: D.A. Danielson and J.R. Snider, "Satellite Motion Around an Oblate Earth: A Perturbation Solution for all Orbital Parameters," Proceedings of the AAS/AJAA Astrodynamics Conference, Stowe, Vermont,1989.

CONFERENCE PRESENTATION: D.A. Daneilson and J.R. Snider, "Satellite Motion Around an Oblate Earth: A Perturbation Solution for all Orbital Parameters," Stowe, Vermont, 1989.

THESIS DIRECTED: J.R. Snider, LTC, USA, "Satellite Motion Around an Oblate Planet: A Perturbation Solution for all Orbital Parameters," Ph. D. Thesis, June 1989.

FINITE ROTATION WITH SMALL STRAIN IN BEAMS AND SHELLS

D.A. Danielson, Associate Professor of Mathematics
Sponsor: NPS Research Council

OBJECTIVE: Provide theoretical foundation for higher order shell theory, useful for predicting mechanical behavior of composite plates and shells.

SUMMARY: The kinematics of beams and plates with small strain are derived from a single unified theory, based upon a decomposition of the rotation.

PUBLICATION: D.A. Danielson, "Finite Rotation with Small Strain in Beams and Shells," Journal of Applied Mechanics. Forthcoming.

BUCKLING OF T-STIFFENED PLATES IN SHIPS AND SUBMARINES

D.A. Danielson, Associate Professor of Mathematics
Sponsor: Office of Naval Research

OBJECTIVE: Develop mathematical model for buckling of stiffened plates, an essential structural component of ships and submarines.

SUMMARY: Thin-walled beams attached to plates and subjected to longitudinal compressive loadings may undergo a torsional-flexural buckling. The stiffeners were mathematically modeled by a refined nonlinear beam theory recently derived, and an analytical solution was obtained to the beam buckling equations. The solution was expressed in terms of a simple formula which yielded loads of T, angle , I, z, and other open cross sections. The predictions were shown to agree with those of other authors, a finite element code, and experiments.

PUBLICATION: D.A. Danielson, D.P. Kihl, D.H. Hodges, "Tripping of Thin-Walled Plating Stiffeners in Axial Compression", to be published in Thin-Walled Structures, 1990.

FIBER OPTIC HYDROPHONES

S.L. Garrett, Professor of Physics
D.A. Danielson, Associate Professor of Mathematics
Sponsor: Office of Naval Research
U.S. Space and Naval Warfare Command

OBJECTIVE: When two optical fibers, which comprise the arms of an interferometer, are wound around the equatorial meridional circumferences of a spheroid, pressure changes induce a differential optical phase shift in the interferometer. We used shell theory to calculate the circumferential strain, polar and equatorial displacement, lowest natural frequency, buckling pressure, and optical pressure sensitivity of such a sensor. Sample designs based on these calculations were compared to other fiber optic hydrophones of similar dimensions and materials.

PUBLICATIONS: D.A. Danielson and S.L. Garrett, "Fiber Optic Flextensional Hydrophones," Journal of Light Wave Technology, Vol. 7, No. 12, Dec. 1989, pp. 1995-2002.

D.A. Brown, S.L. Garrett, and D.A. Danielson, "Fiber Optic Flextensional Hydrophones," Proceedings of the SPIE Symposium, Boston, MA. Sept. 5-8, 1989.

PATENT APPLICATION: Granted by Navy for this work.

NUMERICAL LINEAR ALGEBRA WITH APPLICATIONS TO SIGNAL PROCESSING AND OPTIMIZATION

W.B. Gragg - Professor of Mathematics, Department of Mathematics
Sponsor: NPS Research Council

OBJECTIVE: To develop new reliable and fast algorithms in computational linear algebra which have general applications. In particular, our work on "superfast" Toeplitz solvers and related unitary eigenproblems are fundamental for signal processing applications.

SUMMARY: Intriguing new algorithmic results were found for discrete least squares approximation by trigonometric polynomials. Connections with inverse eigenproblems for unitary Hessenberg matrices lead to recursive procedures for efficiently inserting and deleting data. These algorithms are numerically stable in the sense that they are based on orthogonal (or unitary) transformations. It is anticipated that such a capability may be important in connection with problems related with "aliasing" in Fourier analysis. We have gained familiarity with the elegant programming language Matlab and have developed about one hundred programs which are useful for teaching and research in this area. Matlab's main feature is its ease of use.

PUBLICATIONS: W.B. Gragg, G.S. Ammar and L. Reichel, "Discrete Least Squares Approximations by Trigonometric Polynomials," Submitted for publication.

CONFERENCE PRESENTATIONS: W.B. Gragg, "Going Around on Circles," Northern Illinois University Conference on Linear Algebra, Numerical Linear Algebra, and Applications, Dekalb, Illinois, 29 April, 1989.

W.B. Gragg, "Hermitian Antiquaternion Jacob; Matrices," SIAM Conference on Control in the 90's: Achievements, Opportunities and Challenges," San Francisco, 17 May, 1989.

W.B. Gragg and L. Reichel, "On Singular Values of Hankel Operators of Finite Rank," International Symposium on the Mathematical Theory of Networks and Systems (MTNS-89), Amsterdam, The Netherlands, 19 June, 1989.

W.B. Gragg and L. Reichel, "A Divide and Conquer Method for the Unitary Eigenproblem with Application to Signal Processing," 1989 SIAM National Meeting, San Diego, 17 July, 1989.

W.B. Gragg, "Structured Problems in Numerical Linear Algebra," SIAM 1989 National Meeting, San Diego, 17 July, 1989.

ERROR BOUNDS FOR GAMMA FUNCTION

C.L. Frenzen, Associate Professor of Mathematics
Sponsor: NPS Research Council

OBJECTIVE: Obtain error bounds for the asymptotic expansion of the ratio of two gamma functions valid in the complex plane.

SUMMARY: The asymptotic expansion of the ratio of two gamma functions depending on two complex parameters will be sought as the large variable tends to infinity in the complex plane. Error bounds will be provided for the expansion enabling it to be used for precise numerical computation.

CONFLICT GRAPHS FOR COMMUNICATION NETWORKS

K.A.S. Hefner, Assistant Professor of Mathematics
Sponsor: NPS Research Council

OBJECTIVE: Examine communication networks for channel assignments. Find classes of graphs, which are conflict graphs of networks where a polynomial time algorithms can be used to assign the frequencies. Long term: To redefine the assignment problem as a collection of smaller subproblems, in order to facilitate a more organized approach to the research.

SUMMARY: The problem of assigning frequencies to transmitting/receiving stations was broken down into various subproblems. Two of these problems were funded for AY1990, and follow this summary. It was found that all research to date had centered on NP-complete algorithms. It is possible to relate the graph associated with the interference of stations to the actual network. Using covers of the arcs in the network, a frequency assignment scheme should be able to be developed. Conflict graphs which are interval or square graphs have polynomial time algorithms for frequency assignments, but it was determine that these types of conflict graphs are not usually generated by real communication networks in the military.

PUBLICATIONS: K.A.S. Hefner, "Biclique Covers and Partitions of Digraphs: A Set Theoretic Approach," Congressus Numerantium, forthcoming.

CONFERENCE PRESENTATION: K.A.S. Hefner, "Biclique Covers and Partitions of Digraphs: A Set Theoretic Approach," International Conference on Combinatorics, Graph Theory and Computing; Boca Raton, FL, Feb. 20-24, 1989.

GRAPH THEORETIC SOLUTIONS TO FREQUENCY ASSIGNMENTS PROBLEMS IN COMMUNICATION NETWORKS

K.A.S. Hefner, Assistant Professor of Mathematics
Sponsor: NPS Research Council

OBJECTIVE: Create an algorithm which will decompose a large network into smaller subnetworks. This will facilitate making frequency assignments in polynomial time. Also, for a given conflict graph, find the maximum number of links possible in its associated communication network.

SUMMARY: The problem of finding maximum cliques (decomposition of a network) in a graph is NP-complete. However, if the graph is broken into smaller subgraphs, it can be done more easily. K. Bell, CPT, USA, worked to creatie an algorithm which will decompose a graph. CPT Bell's thesis next year will be based upon this research. The question of the maximum number of links in a network has also attracted student attention. W. Hintze, CPT, USMC, has worked in designing an algorithm which will create the maximum number of links in a network for a given conflict graph. CPT Hintze will also be graduating next year. NOSC has shown interest in the possibility of funding this research in the future.

PUBLICATION: K. Hefner, S. Kim, K. Jones, R. Lundgren, and F. Roberts, "Competition Graphs," Journal of Applied Discrete Mathematics, forthcoming.

STATISTICAL SUPPORT FOR THE JOINT OIL ANALYSIS PROGRAM

T. Jayachandran, Professor of Mathematics
H.J. Larson, Professor of Mathematics
Sponsor: Kelly Air Force Base, Texas

OBJECTIVE: The Joint Oil Analysis Program to analyze used oil samples from critical military equipment such as aircraft engines, gear boxes, etc., to monitor the wear condition of this equipment. The samples are analyzed on a spectrometer and the levels of several wear metals such as iron, silver, aluminum, magnesium and titanium are measured. The observed values are then compared with certain tabulated "critical" values to determine if the equipment is exhibiting an unusual wear condition. Appropriate recommended action is taken based on the results. The two investigators have been conducting statistical studies to examine the efficacy of the program and have recommended several modifications and changes to the procedures over the last ten years. Several of these recommendations have been implemented and are currently operational. The project has finally come to a conclusion. During this last year one of the tasks was to examine the statistical accuracy of the tabulated critical limits for various wear metal/equipment combinations. A general conclusion of the study was that these limits can be tightened without the risk of a significant increase in the number of false calls. The oil analysis program uses several functionally different spectrometers to analyze the samples and, as would be expected, the observations from these spectrometers tend to be different for the same oil specimen. The idea of establishing statistically determined formulas for converting an observation from one type of spectrometer into an "equivalent" observation from another type of spectrometer was also examined. However, because of the non-availability of enough accurate data, it was not possible to develop meaningful and reliable formulas.

PUBLICATION: T. Jayachandran, "An Examination of some B003 Data," Submitted.

THESIS DIRECTED: Moon Soo Choi, Republic of Korean, "A Statistical Analysis of some Oil Analysis Data," Master of Science in Operations Research, March, 1990.

ASYMPTOTIC AND NUMERICAL METHODS IN THE SOLUTION OF SCATTERING FROM SUBMERGED STRUCTURES

C.L. Scandrett, Assistant Professor of Mathematics, Department of Mathematics
G.A. Kriegsmann, Professor of Mathematics, Northwestern University
Sponsor: NPS Research Council

OBJECTIVE: Apply a new approximate method used to decouple fluid/structure interaction problems, to more general structures, and assess their usefulness.

SUMMARY: In addition to the paper published in the Journal of Acoustics Society of America, the methodology has been applied to the problem of scattering from a fluid loaded baffled plate, with marginal success. At high frequencies, the method appears to work well, while at intermediate frequencies, the approximation employed (whereby the fluid/structure interaction is decoupled through the use of an impedance approximation) leads to erroneous results. Reasons and possible remedies to this problem are being considered. Incorporation of non-radiating modes into the impedance approximation may improve the results, as the non-radiating component of the plate's response appears to render the impendence approximation invalid at such frequencies. The impedance approximation is being applied to other physically interesting problems for which there appears to be more promise. In particular, scattering from a fluid loaded baffled membrane which covers a cavity and/or a section of a waveguide are both being considered. Away from resonance of the cavity and cut-off of the waveguide, the new approximation appears to work extremely well. At resonance and cut-off more work needs to be done.

PUBLICATIONS: C. Scandrett and G. Kriegsmann, "Assessment of a New Radiation Damping Model for Structural Acoustic Interactions," J. Acoust. Soc. Amer., 86 788, 1989.

CONFERENCE PRESENTATION: C. Scandrett, "An Approximate Boundary Condition for Structural Acoustic Interactions," 1989 SIAM Annual Meeting, San Diego, CA., July 17-21, 1989.

DEVELOPMENT OF A FINITE ELEMENT PREDICTION MODEL

R.T. Williams, Professor of Meteorology;
A.L. Schoenstadt, Professor of Mathematics
B. Neta, Associate Professor of Mathematics
Sponsor: Office of Naval Research

OBJECTIVE: To develop and test a finite element atmospheric prediction model. This is a continuing project.

SUMMARY: The research on vertical finite element schemes used the linearized baroclinic vorticity-divergence equations for a single horizontal spectral mode. Three finite difference schemes were compared with the three finite element schemes, which had nodal points corresponding to grid points in the finite difference schemes. These numerical schemes were applied to a baroclinic instability situation with linear and hyperbolic wind profiles. A semi-Lagrangian scheme was developed for Burgers' equation. Near the time of discontinuity formation the scheme was much better than finite difference and tau spectral formulations. Further studies of the semi-Lagrangian method were carried out with the one-dimensional shallow water equation with topography. A semi-implicit version gave much better results than the explicit version. The linearized shallow water equations in a channel were solved with a linear cross-channel depth variation. Finite difference solutions were compared with analytic solutions that were written in terms of confluent hypergeometric functions.

PUBLICATIONS: B. Neta and R.T. Williams, "Rossby wave frequencies and group volocities for finite element and finite difference approximations to the vorticity-divergence and primitive forms of the shallow water equations," Mon. Wea. Rev., 117, 1439-1457, July 1989.

H.-C. Kuo and R.T. Williams, "Semi-Lagrangian solutions to the inviscid Burgers equation," Mon. Wea. Rev., accepted for publication.

A.N. Staniforth, R.T. Williams and B. Neta, "Influences of linear depth variations on barotropic Kelvin and Poincare' waves," (in preparation).

THESIS DIRECTED: B. Monk, " Semi-Lagrangian, Semi-Implicit Solutions of the Shallow Water Equations in One Dimension," M.S. thesis, June 1989.

CONFERENCE PRESENTATIONS: B. Neta and R.T. Williams, "Analysis of finite element and finite difference methods for the solution of the vorticity-divergence form of the shallow water equation," International Symposium on Computational Fluid Dynamic, Nagoya, Japan, 28-31 August, 1989.

B. Neta and R.T. Williams, "A comparative study of finite elements and finite difference for weather predictions," Fifth International Symposium on Numerical Methods in Engineering, Lausanne, Switzerland, 11-15 September 1989.

R.T. Williams, A.N. Staniforth and B. Neta, "Solutions of a generalized Sturm-Liouville problem," Computation of Ordinary Differential Equations, London, England, 3-7 July, 1989.

B. Neta, "Analysis of Finite Element and Finite Differences for Sahllow Water Equations," Seminar on Finite Element Flow Analysis, Chuo University, Tokoyo, Japan, August 1989.

DEPARTMENT OF MECHANICAL ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

The primary thrust of the Department of Mechanical Engineering's research program continues to advance the state of knowledge in areas important of the U.S. Navy, in particular those areas involving solid mechanics and composite material optimization; underwater shock and vibration damping; control of dynamic systems; fundamentals of fluid mechanics, hydrodynamics, and heat transfer including application to electronic cooling, welding, boiling, condensation, and applied thermodynamics; and materials science applied to metals and metal matrix composites.

In addition to the research activities of the 18 tenure track faculty, the department has from 8 to 10 adjunct and visiting faculty including the ONT Chair in Surface Ship Technology, held this year by Professor Daryl Metzger from University of Arizona, and at the time of writing by Professor J. Hamilton from Purdue University. Distinguished visitors this year include Dr. J. Lloyd, Michigan State University, Dr. J. Lamar, NASA Dryden Fellow, and we are fortunate to have had Mr. G. Reid as an NSTP assignee from NSWC White Oak Labs. as a visitor.

Results of research are published in the student theses, NPS technical reports, and in papers both presented at, and appearing in, national conference proceedings, and published in the scientific quarterly journals.

SOLID MECHANICS, SHOCK, AND VIBRATION

Professor Young Shin continued his work in the areas of underwater shock and vibration damping sponsored by DTRC, NAVSEA, DARPA, and the DNA as well as the NPS Direct Research Fund. Projects funded by DNA are concerned with the dynamic response and failure under dynamic loading of composite plates under water. The research includes both analytical and experimental studies of UNDEX behavior of S-2 glass/ polyester and aluminum panels. Funded by DTRC, he continued to develop effective means for vibration control of primary structure using constrained layer treatments, tuned dampers, and waveguide absorbers with direct application to the SSN-21 program. In addition, funded by DARPA and NAVSEA, Professor Shin began projects in machinery noise monitoring and diagnostics and the condition monitoring of torpedo ejection pumps (TEP's). The approach taken for TEP's is to investigate the use of Wigner Distribution for time dependent spectral analysis, as the device is basically a transient machine. Professor P. Shin continued his work on design of laminated with stiffener ribs with a view towards optimum design for buckling strength.

DYNAMIC SYSTEMS AND CONTROL

In this area, Professor Healey continued working with the project on Autonomous Underwater Vehicles. Contributing work was done by Professor F. Papoulias, and Professors Kwak, Lee, McGhee (Computer Science), and Professor Cristi (ECE Department). During this year, the design of the NPS AUV2 vehicle progressed to the point where a conceptual design has been finalized and component testing for 4 sonar channels, and two onboard computers for mission level planning and analysis and real time control has been accomplished. Robust autopilot design using Sliding Mode Control theory has demonstrated that advanced autopilots will control highly non-linear vehicles with uncertain hydrodynamic parameters very effectively. Professor Chang has continued his work on the control of flexible structures, again using Sliding Mode Control methods, and has developed an extension of the methodology that will more appropriately handle flexible bodies with largely unknown payload mass. Professor M. Driels jointed the department and has initiated research into the design and development of dexterous end effectors for use in direct drive robotic hands.

FLUID MECHANICS, THERMODYNAMICS, AND HEAT TRANSFER

One of the most active groups in the department, this area covers; convective cooling of electronic components, fluid and thermal aspects of the welding process; field modeling of the spread of fire and smoke in confined spaces; cryogenic heat pipes for motor cooling, and boiling heat transfer with refrigerants; gas turbine flow modeling, and modeling of the flow fields in gas turbine engine test cells; film cooling for turbine blades; heat transfer in boundary layers with embedded vortices; and research in time dependent hydrodynamic flows, vortex/free surface interactions, parachute collapse, and flow forces on cylinders in complex oscillatory flow fields. Professor Joshi continued his activity in electronics cooling with extensive flow visualization studies,

and both analytical and experimental work in thermal modeling of fusion welding processes. Professor Kelleher joined Professor Joshi in the electronics cooling project and also worked on the further development of a simulation program to model the thermal and fluid processes for the FIRE 1 research chamber at NRL. The effects of surface radiation have now been included. Professor Marto has begun to investigate the use of cryogenic heat pipes for the cooling of advanced electric motors, and continued his activity in refrigeration boiling heat transfer by experiments on tube bundles using finned tubes of various kinds. More than 70 different finned tubes have been tested. Professor Pucci continued his long standing work with NAVSEA in the area of gas turbine modeling for the Navy's DDG-51 program, and this year assisted in the organization and evaluation of 2 sets of tests conducted by the shipbuilder acting as the Navy's observer. Additionally, he developed numerical simulations using the Phoenix (a CFD code) program aimed at understanding the complex flow fields within the gas turbine engine exhaust diffuses. Professors Ligrani and Subramanian worked under the external sponsorship of Wright Patterson AFB and NASA Lewis Research Center to continue the program in the understanding of heat transfer in the transitional boundary layer with embedded vortices. The experiments conducted simulate the flow around gas turbine engine blades and the effect of cooling flows injected from cooling holes. Work this year included experimental studies of the influence of harmonically fluctuating components in the main flow stream. Professor Salinas continued his work on the modeling of the flow field inside gas turbine engine test cells. Professor Sarpkaya continued his work on the understanding of time dependent fluid mechanics. His DARPA work deals with investigations into the migration of vortices shed from submarine planes at angles of attack and their interaction with the free surface. His work on separation points for flows around cylinders (smooth and rough) continued with emphasis on multi-frequency harmonic flows, he has performed numerous experiments and analyses toward the evaluation of the behavior of free surface scars generated by rising vortices in terms of Froude numbers, Atwood numbers, and the Vaisala-Brunt frequencies.

MATERIALS SCIENCE

The materials science group was helped by the recent hiring of Professors Fox and Dutta. Professor Dutta has initiated and active research program in metal matrix composites (MMC's), including an investigation into the thermal-mechanical processing for cast Al-SiC composites that will alleviate some of the problems found with current casting technology, and he is also studying experimentally and by finite element modeling, the aging processes, the effects of load transfer, residual stress, and composite yield strength of MMC's. In addition, he is also studying the corrosion behavior and corrosion-fatigue behavior of Graphite/Aluminum composites under sponsorship by NWSC, Crane. Professor Fox, under sponsorship by US Department of Energy and others, has begun an active research program in several areas of interest to the Navy, including the delamination of ceramic/ metal interfaces as thin coating films separate from their ceramic substrates. His basic research in accurate structure factor determination using electron diffraction means continues well and he has begun to investigate the crystallographic and chemical characterization of microstructures in high-strength low alloy steels and their weldments, microstructures arising from heat treatments on Al-Li alloys, and thin film metallic / ceramic interfaces. Professor McNelley continued his activity in the superplastic forming of Aluminum alloys and this year has developed a qualitative model for the occurrence of continuous recrystallization in a progressive manner through a series of deformation and warm rolling. Professor Perkins continues his work in the characterization and understanding of the behavior of high damping alloys which has lead this year to the discovery of a flickering phenomenon in TEM images of certain aged alloys that is thought to be related to their enhanced damping properties.

CONTROL OF SINGLE LINK ROBOT ARM WITH STRUCTURAL STABILITY

L.W. Chang, Assistant Professor of Mechanical Engineering
Sponsor: Naval Research Laboratory

OBJECTIVE: Design advanced controllers for two types of manipulators, ie.e., flexible-link and flexible-joint manipulators.

SUMMARY: Advanced controllers are needed for complex systems such as flexible manipulators. A robust controller based on sliding mode control was design, simulated, and installed on a single-flexible - line manipulator. A torque computed control for a single-flexible-joint manipulator was design and simulated for the third joint of the PUMA 560 robot.

PUBLICATIONS: L.W. Chang and K.S. Park, "A Vertical-plane Motion of an Electrohydraulically-Actuated Single-Flexible-Army," ASME Journal of Dynamic Systems, Measurement, and Control, Submitted.

L.W. Chang and M. Kirkland, "Implementation of a Vertical-plane Motion Control of an Electrohydraulically-Actuated Single-Flexible-Link-Arm," ASME Journal of Dynamic Systems, Measurement, and control, Submitted.

L.W. Chang and T.C. Fan, "A Robust Control of a Vertical-Plane Motion for an Electrohydraulically-Actuated Single Flexible-Arm," In Progress.

THESES DIRECTED: R. Knight, LCDR, USN, "Control System Design of the Flexible Third Joint on the PUMA Robot," M.S., June 1989.

T.C. Fan, LT, Taiwan Navy, "A Robust Control of a Vertical-Plane Motion for an Electrohydraulically-Actuated Single-Flexible-Arm," M.S., June 1989.

FLEXIBLE-BODY CONTROL AND APPLICATIONS

L.W. Chang, Assistant Professor of Mechanical Engineering
Sponsor: Naval Research Laboratory

OBJECTIVE: Continue the study of flexible-body control and its applications.

SUMMARY: Sliding control schemes were developed which provides better performance and greater versatility. In addition, a nonlinear control using inverse dynamics for the PUMA 560 robot with flexible joints was developed. The Newton-Euler Method was applied to derive the inverse dynamics. A mathematical dynamic model for a flexible-body missile in 2-D motion was developed and a control system for the flexible missile was simulated.

PUBLICATIONS: L.W. Chang, "A Versatile Sliding Control with a Second-Order Sliding Condition," International Journal of Control, Forthcoming.

L.W. Chang, "A Straight Sliding Control with a First-Order Plus Integral Sliding Condition," International Journal of Control, Submitted.

L.W. Chang and P.H. Wang, "The Newton-Euler's Inverse Dynamics of Mechanical Manipulators with Elastic Joints," In Progress.

THESES DIRECTED: M. Aysel, LT, Turkish Navy, "The Computer Simulation and Modeling of a Flexible Missile in 2-D Motion," M.S., December 1989.

P.H. Wang, LCDR, Taiwan Navy, "Dynamics and Control of Multi-LInk Robot Manipulators with Joint Flexibility, M.S., December 1989.

ADAPTIVE CONTROL OF A DIRECT DRIVE DEXTEROUS ROBOTIC HAND WITH BILATERAL TACTILE SENSING

M.R. Driels, Professor of Mechanical Engineering
Sponsor: NPS Research Council

OBJECTIVE: The goals of the research are: 1) Develop the mechanical component design of a multi-joined, multi-finger direct drive dexterous hand. 2) Investigate the design of an adaptive control system to operate the and under various grasping and manipulation requirements. 3) Design and develop a tactile display device which relays to the operators finger stimuli from tactile sensors located on the remote dexterous hand.

SUMMARY: Current developments in dexterous, robotic hands rely on the actuation system moving the joint by pulling on tendons, leading to designs which are bulky, low in reliability and high in power consumption. The proposed work will develop a novel actuation system having the actuators (electric motors) located in the finger section of the hand itself. Adaptive control schemes will be studied in order to match the control system characteristics to the task being performed by the hand. Bilateral control of the hand by a human operator will be developed through the use of a tactile display device, allowing the operator to experience haptic telepresence of the remote environment.

CORROSION AND CORROSION-FATIGUE BEHAVIOR OF GRAPHITE ALUMINUM COMPOSITES

I. Dutta, Assistant Professor of Mechanical Engineering
Sponsor: Naval Weapons Support Center

OBJECTIVE: To characterize the corrosion behavior of continuous fiber composites in aqueous marine environments and to study the effects of environments on the corrosion fatigue behavior.

SUMMARY: NWSC, Crane is currently considering the possibility of using Gr-Al composites as electronic module frame materials, which are subjects to thermal and mechanical cyclic loading (fatigue) in conjunction to various marine environments. An effort will be maintained in the coming year to study the effects of pH, sulphur ion contamination from stack gases and heat treatment on the corrosion behavior of Gr-Al composites in aqueous salt solutions. In addition, the fatigue behavior of the composite in these environments will also be studied. Currently, the corrosion work is in progress, while equipment for the corrosion fatigue work is being purchased and put together.

RESIDUAL STRESS EFFECTS AND CORROSION BEHAVIOR OF METAL MATRIX COMPOSITES

I. Dutta, Assistant Professor of Mechanical Engineering
Sponsor: NPS Research Council

OBJECTIVE: 1) To find the effects of residual stresses on composite properties and 2) To characterize the corrosion behavior of continuous fiber composite in aqueous environments.

SUMMARY: The first part of the project is a continuation of the FY89 Research Council sponsored project, where the effect of thermal residual stresses in determining composite flow stress is being studied via Finite Element Modeling. In the second part, a new effort was initiated in June 89 to characterize the corrosion behavior of graphite fiber reinforced aluminum matrix composites in marine environments. This was intended as a seed project for future funding from NWSC, Crane.

THESIS DIRECTED: J.D. King, LT, USN, "Characterize of the Corrosion Behavior of a P130x Graphite-6063 Aluminum Metal Matrix Composite," M.S., December 1989.

EFFECT OF MATRIX MICROSTRUCTURE AND DISLOCATION DENSITY ON THE MECHANICAL PROPERTIES OF DISCONTINUOUS METAL MATRIX COMPOSITES

I. Dutta, Assistant Professor of Mechanical Engineering
Sponsor: NPS Research Council

OBJECTIVE: To investigate the cause of accelerated aging in metal matrix composites and to determine the effect of matrix microstructure on the mechanical properties of MMCs from a mechanistic standpoint.

SUMMARY: This project, which is currently in progress, has two different part. In the first part, an effort is being made to look at the effect of reinforcements on the early states of precipitation in composite matrices and study the precipitation kinetics. Resistivity measurements have revealed that the aging process is accelerated in the composite from the very start. Differential scanning calorimetric studies are now being conducted to measure the thermodynamic and kinetic parameters influencing the aging in MMCs. In the second part, the effect of load the load transfer, dislocation density and residual stresses on the composite yield strength are being studied via continuum mechanics modelling. The results obtained so far indicate that residual stresses reduce the contribution of load transfer to composite strengthening. Further modelling work using FEM is in progress.

PUBLICATIONS: I. Dutta, "The Nature and the Effect of Thermal Residual Stresses in Discontinuous Fiber Reinforced Metal Matrix Composites," Submitted to Composites Science and Technology, November 1989.

CONFERENCE PRESENTATION: I. Dutta, "Residual Stresses and their Effect on Composite Strength," Presented at the 1989 Fall Meeting of TMS-AIME, Indianapolis, Indiana, 4 October 1989.

THESES DIRECTED: J.L. Hafley, LT, USN, "A Comparison of the Aging Kinetics of a Cast Alumina-6061 Al MMC and a Monolithic 6061 Al Alloy," M.S., December 1989.

ACCURATE STRUCTURE FACTOR MEASURE DIFFRACTION

A.G. Fox, Associate Professor of Mechanical Engineering, Materials Science Group
Sponsor: Department of Energy, Science, and Engineering Research Council (U.K.) and NPS

OBJECTIVE: To accurately measure the low-angle structure factors of selected materials by electron diffraction so that their electronic bonding mechanisms can be investigated.

SUMMARY: A knowledge of the distribution of bonding electrons in solids can give important information about their physical properties. One way to gain such knowledge is to accurately measure the low-angle structure factors by some means, and then use these to generate maps of the electron charge distributions. In the present work, electron diffraction has been used to measure the low-angle structure of Be,Al,Cr,Fe,Cu,Zn and BNiAl. Electron charge distributions have been generated for these metals and alloys and important bonding information is emerging about these materials.

PUBLICATIONS: A.G. Fox, M.A. O'Keefe, and M.A. Tabbernor, "Relativistic-Hartree-Fock X-ray and Electron Atomic Scattering Factors and High Angles," Acta. Cryst. A45,786, 1989.

A.G. Fox and M.A. Tabbernor, "The Accurate Measurement of the 0002 and 1013 Low-Angle Atomic Scattering Factors and Zinc by Electron Diffraction," Philosophical Magazine Letters, Submitted.

A.G. Fox, M.A. Tabbernor, and R.M. Fisher, "Low-Angle Atomic Scattering Factors and Charge Density of Aluminum," Physical Review B, Submitted.

CONFERENCE PRESENTATIONS: A.G. Fox, M.A. Tabbernor, and R.M. Fisher, "Bonding Charge Densities of Al and Cu Determined by Electron Diffraction," Proceedings of the 17th Annual Meeting of the Electron Microscopy Society of America, San Antonio, TX, August 1989.

THE CRYSTALLOGRAPHIC AND CHEMICAL CHARACTERIZATION OF MICROSTRUCTURE AND NON-METALLIC INCLUSIONS IN HIGH-STRENGTH, LOW-ALLOY (HSLA) STEELS AND THEIR WELDMENTS

A. G. Fox, Associate Professor of Mechanical Engineering, Materials Science Group
Sponsor: NPS Research Center

OBJECTIVE: To investigate the microstructure and mechanical properties of HY and HSLA 80-130 series and their weldments to evaluate new weld consumables and parent steels for Naval shipbuilding applications.

SUMMARY: In recent years, the U.S. Navy has been replacing the HY80-100 series of high strength alloy steels with their high-strength low-alloy (HSLA) equivalents. This is being done because the stringent weld pre-heat requirements associated with the HY steels are not necessary for the HSLA series. So, despite the higher manufacturing costs of high-strength, low-alloy steels, the U.S. Navy should make significant savings by changing over to these for ship and submarine construction. This project aims to support these objectives with fundamental physical metallurgy studies at NPS. A start has already been made, and one MS thesis has been completed.

THESIS DIRECTED: B. Douglas, CPT, U.S.M.C., "Non-Metallic Inclusions in HSLA Steel Weldments," M.S., December 1989.

THE PHASES AND MICROSTRUCTURES RESULTING FROM VARIOUS HEAT TREATMENTS ON Al-Li AEROSPACE ALLOYS

A.G. Fox, Associate Professor of Mechanical Engineering, Materials Science Group
Sponsor: NPS Research Council and Department of Energy

OBJECTIVE: To fully understand the relationships between heat treatment, microstructure and mechanical properties for Al-Li base alloys so that their range of applications in the aerospace industry can be extended.

SUMMARY: The relationship between thermo-mechanical processing, microstructure, and physical and mechanical properties is important for any alloy system. Despite the many proposed uses of low density, high stiffness Al-Li alloys, particularly in aerospace applications, many have not been realized because the necessary properties have not been achieved. One of the major reasons for this is because the fundamental properties of these alloys is not properly understood. This work initiated by Professors Fox, Thomas, and Radmilovic when Professor Fox was at the Department of Energy, aims to clarify the basic physical properties of Al-Li base alloys so that more potential uses of these can be realized. Important information has already been generated and publications produced.

PUBLICATIONS: V. Radmilovic, A.G. Fox, R.M. Fisher, and G. Thomas, "Lithium Depletion in Precipitate Free Zone in Al-Li Base Alloys," Scripta Metallurgica 23, 75, 1989.

V. Radmilovic, A.G. Fox, and G. Thomas, "Spinodal Decomposition of Al-rich Al-Li Alloys," Acta Metallurgica 37,2385, 1989.

THESES DIRECTED: E.F. Goodson, LT, USN, "The Stress and Temperature Dependence of Creep in an Al-2.0 wt.% Li Alloy," M.S., December 1989.

PLANNING, NAVIGATION, DYNAMICS AND CONTROL OF AUTONOMOUS UNDERWATER VEHICLES

A.J. Healey, Professor and Chairman of Mechanical Engineering
R.B. McGhee, Professor and Chairman of Computer Science
Y.-J. Lee, Assistant Professor of Computer Science
S.Kwak, Adjunct Research Professor of Computer Science
R. Cristi, Associate Professor Electrical and Computer Engineering
F.A. Papoulias, Assistant Professor of Mechanical Engineering
G. Reid, NSTEP Assignment from NSWC
Sponsor: Naval Surface Weapons Center

OBJECTIVE: This research project is a long term continuing program to investigate and improve basic technologies related to the real time control, artificial intelligence, and computer architectures needed for the support of Autonomous Underwater Vehicles.

SUMMARY: The objective to be met is to demonstrate fully autonomous behavior in a controlled environment. Progress for this reporting period has included a major effort in the development of Sliding Mode Controllers for both steering and depth changing control of vehicles of the type to be used for future AUV operations. An extensive computer graphics simulation using an IRIS workstation together with an AI based mission planning software package has been developed. Theoretical studies in the design of adaptive *autopilots* have produced encouraging results. A plan has been followed to build a second generation testbed vehicle that will be 360 lbs. in weight and carry 4 sonar channels, 2 on-board computers (an MS-DOS laptop machine for data gathering and mission level control and a GESPAC Motorola 68020 based machine for real-time control). A highly maneuverable design has been generated, is present under construction, and tests are underway for the propulsion system, including a novel thruster design.

PUBLICATIONS: F.A. Papoulias, R. Cristi, D. Marco, and A.J. Healey, "Modeling Sliding Mode Control Design and Visual Simulation of AUV Dive Plane Dynamic Response," Proceedings of the 6th Unmanned, Untethered Submersible Technology, Washington, DC., June 12-14, 1989.

A.J. Healey, F.A. Papoulias, and F. MacDonald, "Design and Experimental Verification of a Model Based Compensator for Rapid AUV Depth Control," Proceedings of the 6th Unmanned, Untethered Submersible Technology, Washington, DC, June 12-14, 1989.

R. Cristi and A.J. Healey, "Adaptive Identification and Control of an Autonomous Underwater Vehicle," Proceedings of the 6th Unmanned, Untethered Submersible Technology, Washington, DC, June 12-14, 1989.

THESES DIRECTED: G.S. MacDonald, "Model Based Design and Verification of a Rapid Dive Controller for an Autonomous Underwater Vehicle," M.E., March 1989.

D. Lorhammer, "An Experimental Study of an Acoustic Ranging System for an AUV Obstacle Avoidance," M.S., September 1989.

J.N. Sur, "Design of a Dive Plane Sliding Mode Compensator for an Autonomous Underwater Vehicle," M.S., September 1989.

M. Good, "Design and Construction of a Second Generation Autonomous Underwater Vehicle," M.S., December 1989.

M.A. Schwartz, "Kalman Filtering for Adaptive Depth Steering and Roll Control of an Autonomous Underwater Vehicle," M.S., March 1989.

M. Williams, "Real-Time Implementation of an Adaptive Controller for a Submersible," M.S., December 1989.

D.B. Nordman, "A Computer Simulation Study of Mission Planning and Control for the NPS Autonomous Underwater Vehicle," M.S., June 1989.

R.C. Rogers, "A Study of 3-D Visualization and Knowledge Based Mission Planning and Control for the NPS Model 2 Autonomous Underwater Vehicle," M.S., December 1989.

HEAT TRANSFER AND FLUID FLOW IN FUSION WELDING

Y. Joshi, Assistant Professor of Mechanical Engineering
Sponsor: National Science Foundation

OBJECTIVE: As part of a continuing initiative to study the heat transfer and fluid flow associated with fusion welding processes.

SUMMARY: The research reported here was started during FY88. It involves computational modeling and accompanying experimental investigations of heat transfer and fluid flow processes during fusion welding. During the past year, a three-dimensional computational model of heat transfer in fusion welding was developed. In high welding current applications, fluid flow within the fusion zone may significantly alter the weld-pool shape and cooling rates compared to a pure diffusion situation. A two-dimensional model was developed to study these effects. The model uses an enthalpy formulation of the energy equation and solves the governing equation in the primitive variables form. Results of this model will be compared with the conduction model and the laser vision system measurements.

PUBLICATIONS: Y. Joshi, "A Two-Dimensional Transient Model of Heat Transfer and Fluid Flow within Weldpools," In Progress.

THESIS DIRECTED: R.L. Ule, LCDR, USN, "A Study of the Thermal Profiles During Autogenous Arc Welding," M.S., March 1989.

COMPUTATIONS AND EXPERIMENTS ON HEAT TRANSFER AND FLUID DYNAMICS OF FUSION WELDING

Y. Joshi, Assistant Professor of Mechanical Engineering
Sponsor: David Taylor Research Center

OBJECTIVE: A continuing investigation of applications of heat transfer and fluid flow in the automation of fusion welding processes.

SUMMARY: Heat transfer and fluid flow patterns during fusion welding are known to be modified by various anomalies during the process. These need to be detected and corrected systematically in an automated arrangement. This study aims to characterize these defects through measurements and models of surface temperatures and weld-pool geometry. Several modifications to a recently developed three-dimensional heat conduction model were made to enhance its capabilities. These included the incorporation of a generalized thermal energy input capability and improvements in the study of impurity characterization within the code. Additional changes to make the code more general are continuing. To carry out the experimental validation of the code, a laser vision system was acquired and will soon be available for examining fluid flow patterns during fusion welding.

PUBLICATIONS: Y. Joshi, R.L. Ule, and E.B. Sedy, "A New Approach for Modeling Heat Transfer During Autogenous Arc Welding," In Progress.

CONFERENCE PRESENTATIONS: R.L. Ule and Y. Joshi, "Three-Dimensional, Transient Heat Transfer Computations of Autogenous Arc Welding," Presented at the ASME/AICHE/ANS National Heat Transfer Conference, Philadelphia, August 6-9, 1989. Also published in Heat Transfer in Manufacturing and Materials Processing, HTD, Vol 113, pp. 131-141, 1989.

THESIS DIRECTED: R.L. Ule, LCDR, USN, "A Study of the Thermal Profiles During Autogenous Arc Welding," M.S., March 1989.

CONVECTIVE COOLING OF ELECTRONIC EQUIPMENT EXPERIMENTS AND COMPUTATIONS

Y. Joshi, Assistant Professor of Mechanical Engineering
M.D. Kelleher, Professor of Mechanical Engineering
B. Neta, Associate Professor of Mathematics
Sponsor: Naval Weapons Support Center

OBJECTIVE: As part of a multi-year effort, investigation of convective flow and heat transfer characteristics of simulated and actual electronic components.

SUMMARY: Progress in the semiconductor device manufacturing techniques have resulted in dramatic increases in heat fluxes at the various levels of electronic packaging. Of the various techniques available for the thermal management of electronic equipment attention was focused on convective cooling. This effort was initiated in FY88 and has been cost-shared by NWSC from the beginning. During the present reporting period, the conjugate heat transfer processes associated with liquid cooling of electronic devices were examined experimentally and computationally. The geometries experimentally investigated included both channels and fluid filled enclosures containing arrays of heated elements. Extensive flow visualizations and temperature measurements during liquid immersion cooling were made in order to provide a predictive capability for transport rates to the thermal designer. Two-dimensional conjugate computations were carried out to simulate experiments on heat transfer from isolated components. Development of a three-dimensional code for these applications was also initiated.

PUBLICATIONS: Y. Joshi, T. Willson, and S.J. Hazard, "An Experimental Study of Natural Convect.on Cooling of an Array of Heated Protrusions in a Vertical Channel of Water," Journal of Electronic Packaging Transactions of ASME, Vol. 111, pp. 33-40, 1989.

Y. Joshi, T. Willson, and S.J. Hazard, "An Experimental Study of Natural Convection From an Array of Heated Protrusions on a Vertical Surface in Water," Journal of Electronic Packaging, Transactions of ASME, Vol. 111, pp. 121-128, 1989.

Y. Joshi and D.L. Knight, "Natural Convection From a Column of Flush Heat Sources in a Vertical Channel in Water," In Progress.

S.B. Sathe and Y. Joshi, "A Numerical Investigation of Conjugate Heat Transfer From a Protrusion Immersed in a Liquid," In Progress.

THESES DIRECTED: A.O. Gaiser, LT, USN, "Natural Convection Liquid Immersion Cooling of High Density Columns of Discrete Heat Sources in a Vertical Channel," M.S., June 1989.

M. Powell, LT, USN, "Natural Convection in a Rectangular Enclosure Due to Heated Protrusions: Effects of Fluid Prandtl Number and Selective Component Powering," M.S., September 1989.

R. Paje, LT, USN, "Liquid Immersion Cooling of Leadless Ceramic Chip Carriers in Dielectric Fluids," M.S., September 1989.

FIELD MODELING OF FIRE AND SMOKE SPREAD IN CONFINED SPACES

M.D. Kelleher, Professor of Mechanical Engineering
K.T. Yang, Professor of Engineering
Sponsor: Naval Research Laboratory

OBJECTIVE: Develop a finite difference numerical model for the realistic determination of the time dependent fire and smoke spread in confined spaces. This is used to be used to simulate various fire scenarios in submarines and surface ships for fire safety and design considerations.

SUMMARY: A finite difference model to simulate the spread of fire and smoke in the FIRE-I research chamber at the Naval Research Laboratory has been developed. The present version of the model uses a system of general orthogonal coordinates so that the specification of the geometry is not a major constraint. The model is also capable of including the presence of solid objects or obstruction, such as machinery components, within the enclosure. The effects of surface radiation as well as volumetric gaseous radiation have also been included. The model can also accommodate the presence of force ventilation within the space so that the presence of fans or ventilation ducts can be included. Algorithms are being developed to incorporate combustion processes in the model. Graphics post-processing capabilities are also being developed that enhance the presentation of the results.

PUBLICATIONS: M.D. Kelleher, J. Raycraft, H.Q. Yang, and K.T. Yang, "Fire Spread in a Three-Dimensional Pressure Vessel with Radiation Exchange and Wall Heat Losses," International Journal of Mathematical and Computer Modeling, Forthcoming.

CONFERENCE PRESENTATION: M.D. Kelleher, J. Raycraft, H.Q. Yang, and K.T. Yang, "Fire Spread in a Three-Dimensional Pressure Vessel with Radiation Exchange and Wall Heat Losses," 7th International Conference on Mathematical and Computer Modeling, Chicago, IL, 2-4 August 1989.

STUDY OF THE EFFECTS OF CENTRIFUGAL INSTABILITIES ON TRANSITION FROM LAMINAR TO TURBULENT FLOW IN CURVED CHANNELS FOR DEAN NUMBERS FROM 160 TO FULLY TURBULENT CONDITIONS

P.M. Ligrani, Associate Professor of Mechanical Engineering
Sponsor: Propulsion Directorate, U.S. Army Aviation Research
and Technology Activity-AVSCOM, NASA-Lewis Research Center

OBJECTIVE: To study the effects of centrifugal instabilities on transition from laminar to turbulent flow in curved channels for Dean numbers from 160 to fully turbulent conditions. Of particular interest is the development of Dean vortices and their influences on the later stages of transition.

SUMMARY: The structure and development of flow in a curved rectangular channel with 40 to 1 aspect ration is to be studied. Results are to be obtained for Dean numbers ranging from 160 to values where fully turbulent flow is present. of interest are the effects of centrifugal instabilities on: 1) convective heat transfer processes, and 2) the later stages of transition from laminar to turbulent flow. The experimental data are also intended to be used for comparison with and development of computational and simulation models of curved channel flows. In order to understand flow characteristics, high-speed movies and still photographs are to be made of the flow when it is visualized using smoke. Spatially resolved fluctuations of wall skin friction are to be measured using an array of wall mounted hot-film probes. Measurements are also to be made of wall heat transfer, man velocity components, mean vorticity components, and spectra of voltage signals from subminiature hot-wire probes.

EFFECTS OF UNSTEADINESS ON LAMINAR-TURBULENT TRANSITION IN STRAIGHT CHANNEL FLOW

P.M. Ligrani, Associate Professor of Mechanical Engineering
C.S. Subramanian, Adjunct Research Professor of Mechanical Engineering
Sponsor: Office of Naval Research

OBJECTIVE: To investigate the influences of imposed, bulk flow unsteadiness on transition in a straight channel. Of particular interest are the interactions between the imposed unsteadiness and transition flow phenomena and, during these interactions, whether certain frequencies and amplitudes of unsteadiness stabilize or de-stabilize transition events.

SUMMARY: Results from this study will elucidate fundamental mechanisms operative during the laminar/turbulent transition process as it is affected by imposed bulk flow unsteadiness. Information will be obtained on : 1) parameters governing the unsteady interactions between the imposed bulk flow unsteadiness and transition phenomena, and 2) how heat transfer in the transitioning flow is affected by the imposed bulk flow unsteadiness. Results for Reynolds numbers from 1400-8400 and Strouhal number Str from 0.0004 to 0.050 show different subcritical transition events including two-and three-dimensional Tollmien-Schlichting waves, vortex-array type motions evidenced by smoke swirls (normal /span planes) and ribbon-like patterns (stream/span planes), turbulent spots, and fully turbulent flow. Longitudinal fluctuating intensities near the edge of the Stokes layer are reduced by imposed unsteadiness at 1 Hz for $2000<Re<2400$ or $0.032>Str>0.028$. At 2 Hz, this occurs for $2200<Re<2400$ or $0.059>Str>0.054$. Within the range of Str so far considered, transition events (especially Tollmien-Schlichting waves) appear at lower Re and persist over a wider range of Re compared to flows with no unsteadiness.

PUBLICATIONS: C.S. Subramanian, P.M. Ligrani, T.M. Coumes, F.J. Greco, H. Koth, and J.M. Longest, "STudy of the Imposition of Bulk Flow Unsteadiness on Plan Channel Flow at Low Strouhal Numbers," Experimental Thermal and Fluid Science, Submitted.

P.M. Ligrani and C.S. Subramanian, "Effects Imposed Bulk Flow Unsteadiness at Low Strouhal Numbers on Laminar-Turbulent Transition in a Straight Channel with 40 to 1 Aspect Ratio," Physics of Fluids, In Progress.

ADVANCED COOLING OF ELECTRIC MOTORS

P.J. Marto, Distinguished Professor of Mechanical Engineering
A.G. Michael, Adjunct Research Professor of Mechanical Engineering
Sponsor: David Taylor Research Center

OBJECTIVE: Study the thermal performance of large electric motors being cooled by either forced convection of oil or water, or by integral heat pipes.

SUMMARY: Efficient motors and generators are especially important for Naval application on ships and submarines. This project has examined several advanced cooling schemes that show promise for future use. During this reporting period, however, at the request of the sponsor, attention was focused on a new problem involving the use of cryogenic heat pipe thermal diodes as part of a magnetic refrigeration system in space. Efforts were therefore made to assess the cryogenic heat pipe literature to examine the feasibility of using heat pipe switches in space at temperatures between 4-25K. Preliminary efforts were made to establish a dynamic model of cryogenic heat pipe switches. A complete model remains to be established in order to predict transient performance.

ENHANCED BOILING AND CONDENSATION OF R-114

P.J. Marto, Distinguished Professor of Mechanical Engineering
A.G. Michael, Adjunct Research Professor of Mechanical Engineering
Sponsor: David Taylor Research Center

OBJECTIVE: Verify design information provided to the Navy by manufacturers of Navy water chillers and determine if the best possible heat transfer rates are being achieved.

SUMMARY: This is an on-going project that began in 1985. Initially, experiments were conducted with a single-tube evaporator apparatus. Boiling heat transfer coefficients were obtained within R-114/oil mixtures using a variety of enhanced boiling surfaces. Following this work, a small bundle apparatus was constructed to simulate conditions inside a Navy refrigeration plant evaporator. During this reporting period, this bundle apparatus was operated with smooth tubes, finned tubes, and High Flux tubes. The influence of oil concentration on R-114 boiling behavior in the bundle was determined for each type of boiling surface. Remaining tests will examine one or two more boiling surfaces as well as enhanced condensation phenomena.

CONFERENCE PRESENTATION: P.J. Marto, "Nucleate Pool Boiling of R-114/Oil Mixtures from Enhanced Surfaces," Eurotherm Seminar No. 8, Advances in Pool Boiling Heat Transfer, Paderborn, Germany, 11-12 May 1989.

THESES DIRECTED: C.L. Anderson, LT, USN, "Nucleate Pool Boiling Performance of Smooth and Finned Tube Bundles in R-113 and R-114/Oil Mixtures," M.S., June 1989.

N. Akcasayar, LT, Turkish Navy, "Nucleate Pool Boiling Performance of Finned and High Flux Tube Bundles in R-114/Oil Mixtures," M.S., December 1989.

FILM CONDENSATION HEAT TRANSFER ENHANCEMENT ON HORIZONTAL FINNED TUBES

P.J. Marto, Distinguished Professor of Mechanical Engineering
A.G. Michael, Adjunct Research Professor of Mechanical Engineering
J.W. Rose, Professor of Mechanical Engineering

OBJECTIVE: Experimentally determine an optimum finned tube geometry for a given condensing fluid that would maximize the heat transfer rate, and attempt to predict this performance with a suitable design correlation.

SUMMARY: This project started in 1986 and was completed on 31 December 1989. An experimental apparatus has been built that has allowed the testing of more than 70 different finned tubes with steam and refrigerants. The apparatus has been modified to permit tests showing the influence of vapor velocity as well as condensate inundation. Vapor velocity apparently has a smaller effect on finned tubes than on smooth ones, and condensate inundation effects are also smaller than for smooth tubes. Efforts are now underway to assimilate all the data in order to investigate if a correlation of the data is feasible.

PUBLICATIONS: P.J. Marto, D. Zebrowski, A.S. Wanniarachchi, and J.W. Rose, "An Experimental Study of R-113 Film condensation on Horizontal, Integral-Fin Tubes," Journal of Heat Transfer, 112, Forthcoming.

CONFERENCE PRESENTATIONS: A.G. Michael, P.J. Marto, A.S. Wanniarachchi, and J.W. Rose, "Effect of Vapor Velocity During Condensation on Horizontal Smooth and Finned Tubes," ASME Winter Annual Meeting, San Francisco, 10-15 December 1989.

THESES DIRECTED: J.M. Coumes, LT, USN, "Some Aspects of Film Condensation of Steam on Finned Tubes," M.S., December 1989.

ULTRA-FINE GRAINED SUPERPLASTIC ALUMINUM ALLOYS: THERMOMECHANICAL PROCESSING AND MICROSTRUCTURAL DEVELOPMENT

T.R. McNelley, Professor of Mechanical Engineering

Sponsor: Naval Air Systems Command

OBJECTIVE: To conduct fundamental research into the development of refined microstructures in Al-based alloys by means of thermomechanical processing, with particular emphasis on the enhancement of superplastic response of the materials.

SUMMARY: A qualitative model for the occurrence of continuous recrystallization in a progressive manner trough a series of deformation and annealing cycles in warm rolling has been proposed. The model is capable of predicting the dependence of the resultant superplastic response on warm rolling parameters such as reduction per pass and reheating interval between rolling passes. Further investigation of grain boundary character has revealed that warm rolling under conditions allowing sufficient time for recovery results in retention of a strong Cu-texture component, the evolution of high angle boundaries in a fine-grained microstructure and the absence of a low-index coincident site boundaries. Such structures support extensive superplasticity in Al-Mg alloys. In contrast, suppression of recovery *results in a Brass-texture* component, low angle boundaries and retention of twin-related, low-index coincident site boundaries. This latter structure is not superplastic. These methods are being adapted to Al-based alloys other than Al-Mg materials.

PUBLICATIONS: H.J. McQueen, A. Salama, and T.R. McNelley, "Hot Working and Resultant 300 Degrees C Ductility of Al-Fe and Fl-Fe-Co Alloys," Scripta Metallurgica, Vol. 2, pp. 273-178,1989.

R. Crooks, T.R. McNelley, and S.J. Hales, "Microstructural Refinement via continuous Recrystallization in Superplastic Aluminum Alloys," Superplasticity and Superplastic Forming, The Metallurgical Society of AIME, pp. 389-395, 1989.

S.J. Hales, I.G. Munro, and T.R. McNelley, "Superplasticity in an Al-Mg-Li Alloy Elevated Temperature," Scripta Metallurgica, vol. 23, pp. 967-982, 1989.

T.R. McNelley, S.J. Hales, and I.G. Munro, "Superplasticity at 300 Degrees C in Moderate Strength Low Density Al-Mg-Li Alloys," Light Weight Alloys for Aerospace Applications, The Metallurgical Society of AIME, pp. 397-408, 1989.

S.J. Hales, T.R. McNelley, and G.E. Groh, "Intermediate Temperature Thermomechanical Processing of Al 2090 for Superplasticity," Proceedings of the 5th International Conference on Al-Li Alloys, vol 1, pp. 211-222, 1989.

T.R. McNelley, D.J. Michael, and A. Salama, "The Mg-Concentration Dependence of the Strength of Al-Mg Alloys During Glide-Controlled Deformation," Vol. 23, pp. 1657-1662, 1989.

T.R. McNelley, "Recrystallization and Superplasticity at 300 Degrees C in Al-Mg Alloys: I Experimental Evidence," Metallurgical Transactions, Submitted.

S.J. Hales, T.R. McNelley, and H.J. McQueen, "Recrystallization at 300 Degrees C in Al-Mg Alloys: II - A Qualitative Model," Submitted.

CONFERENCE PRESENTATIONS: T.R. McNelley, S.J. Hales, and I.G. Munro, "Superplasticity at 300 Degrees C in Moderate Strength Low Density Al-Mg-Li Alloys," Symposium on Light Weight Alloys for Aerospace Applications, 118th Annual Meeting of AIME Las Vegas, NV, February 28 - March 2, 1989.

S.J. Hales, T.R. McNelley, and G.E. Groh, "Intermediate Temperature Thermomechanical Processing of Al 2090 for Superplasticity," 5th International Conference on Aluminum Lithium Alloys, Williamsburg, VA, 27-31 March 1989.

THESES DIRECTED: D. O'Mara, "Effect of Heating Rate to Test Temperature on Superplastic Response in an Al-8%Mg-1%Li-0.2%Zr Alloy," M.S., Mar. 89.

M.B. Choudry, "Thermomechanical Processing of Aluminum Alloy 2090 for Superplasticity," Mar.89.

M.W. Reedy, "An Approach to Low Temperature, High Strain Rate Superplasticity in Aluminum Alloy 2090," M.S., June 1989.

A.P. Chester, "Optimizing Superplastic Response in NAVALITE: A Lithium Containing Aluminum-Magnesium Alloy," June 1989.

J. Ratkovich, "Processing and Elevated Temperature Ductility of Aluminum Alloy 7475," M.S., June 1989.

T.E. Gorsuch, "The Roles of Strain and Reheating Interval in the Continuous Recrystallization During Thermomechanical Processing by Warm Rolling of an Al-Mg Alloy," December 1989.

THERMOMECHANICAL PROCESSING OF METAL MATRIX COMPOSITES

T.R. McNelley, Professor of Mechanical Engineering
I. Dutta, Assistant Professor of Mechanical Engineering

OBJECTIVE: To investigate the feasiblity of improving the mechanical properties of Al based cast metal matrix composites utilizing SiC or Alz03 particulate additions.

SUMMARY: A cast 5083 Al-SiCp material has been obtained from a commercial vendor. Metallographic examination has determined that the cast material exhibits an inhomogeneous distribution of the SiCp addition as well as a non-equilibrium microstructure. Processing by forging and rolling operations results in homogenization of the particles and elimination of solidification defects in the cast composite. Mechanical testing reveals that the processing results in substantially increased ductility although the yield and ultimate strengths are not significantly affected.

PUBLICATIONS: I. Dutta, C.F. Triedemann, and T.R. McNelley, "Effects of Thermomechanical Processing on the Properties of a Cast 5083 Al-SiCp Metal Matrix Composite," Naval Postgraduate School Technical Report, NPS69-90-01, Nov. 1989.

ELEVATED TEMPERATURE DEFORMATION IN Al-Li ALLOYS

T.R. McNelley, Professor of Mechanical Engineering

OBJECTIVE: To determine the influence of Li additions to Al, in the range up to two wt. pct. and at temperatures above 0.5Tm, where Tm is the absolute melting temperature, on the stress and temperature dependence of creep in binary Al-Li alloys.

SUMMARY: Material representing three Lithium concentrations, 0.5 wt. pct. 1.0 wt. pct., and 2.0 wt. ptc., have been obtained from the Naval Surface Weapons Center, White Oak, MD. These materials were cast under inert gas to assure minimum contamination levels. Billets from each casting have been homogenized and hot rolled to a thickness of 2.0 mm and test samples have been prepared. Creep tests have been accomplished on the 2.0 Li alloy. All tests have been conducted under isostress conditions and some samples have been thermally cycles (to obtain activation energy data directly) while others have been tested to failure under constant temperature conditions. The stress dependence of creep is the same as that of pure Al as reflected in the stress exponent n (=d log E/d log o) which was determined to have a value of = 5. Evidence for subgrain formation was the same as that of Al at temperatures above 500 degrees C. However, at lower temperatures the activation energy became progressively higher than that of the pure metal. This was associated with ordering of Li in the Al lattice which independent research has shown to begin on cooling below T = 470 degrees C.

THESIS DIRECTED: E.F. Goodson, "The Stress and Temperature Dependence of Creep in Al-2Wt. Pct. Li Alloy," M.S., December 1989.

THE INFLUENCE OF MICROPOROSITY ON THE BEHAVIOR OF M-50 BEARING STEEL

T.R. McNelley, Professor of Mechanical Engineering
Sponsor: Wright Aeronautical Laboratories

OBJECTIVE: To determine the effect of microporosity on the rolling contact fatigue resistance of M-50 bearing steel and the effectiveness of hot isostatic pressing (HIP) in closing the porosity.

SUMMARY: Microporosity, originally documented in this laboratory, has been confirmed in other laboratories to exist in many heats of M-50 aircraft engine bearing steel. It has been demonstrated that such porosity may be closed by hot isostatic pressing (HIP) but that the micropores reopen upon subsequent reheating for austenitization in final hardening. Rolling contact fatigue testing has demonstrated that materials HIPed in the course of heat treatment behave identically with material not subject to HIP, at least within statistical limits. It has been noted that fatigue cracks do interact with insoluble carbides, near which micropores are also seen. It is thug suggested that measure be instituted to avoid the formation of the porosity in original manufacture of such steels.

GAS TURBINE INSTALLATIONS ON THE DDG-51

P.F. Pucci, Professor of Mechanical Engineering
Sponsor: Naval Sea Systems Command

OBJECTIVE: Monitor the design and model testing of the inlet air and exhaust gas systems of the gas turbine installations on the DDG-51 class ships.

SUMMARY: Two sets of exhaust gas sy ems tests and one set of inlet air system tests were run at the Aeronautical and Astronautical Research Laboratory of Ohio State University in Columbus, Ohio. These test were conducted by the shipbuilder to verify the design performance. The principle investigator witnessed/observed these test, acting as the Navy's observer. In addition to observing the tests at Ohio State, the principal investigator traveled to the Gas Turbine Engine Land Based Engineering Site at the Naval Surface Ship Engineering Station in Philadelphia, to discuss and engine malfunction at the site.

ANALYTIC MODEL OF GAS TURBINE FLOW SYSTEMS

P.F. Pucci, Professor of Mechanical Engineering
Sponsor: Naval Sea Systems Command

OBJECTIVE: The exhaust gas diffuser of each of two proposed gas turbine engines were modelled by a commerically available, three-dimensional finite volume numerical computer code for the solution of fluid flow and heat transfer problems.

SUMMARY: The commercial fluid mechanics code PHONICS was used to model two gas turbine engine exhaust diffusers. A parallel physical model test program,one-fifth scale, of the same two diffusers is being conducted at the David Taylor Research Center at Annapolis, MD. The computer model simulated the DTRC physical model so that results of the computer models and the results of the scale models could be compared. The general flow patterns and relative velocities predicted by the computer model were in the general agreement with observed flow visualization runs made at DTRC. The absolute magnitudes of the velocity and pressure distributions could not be compared because of the sparse data collected at DTRC.

THESES DIRECTED: R.D. Berkey, LT, USN, "Numerical Simulation of the Fluid Flow Through a Gas Turbine Exhaust Diffuser," M.S., September 1989.

N.C. Stubits, LT, USN, "Numerical Simulation of the Fluid Through a Gas Turbine Engine Exhaust Diffuser," M.S., September 1989.

THREE-DIMENSIONAL MODELING OF FLOWS WITHIN THE GAS TURBINE ENGINE TEST CELLS

D. Salinas, Associate Professor of Mechanical Engineering
Sponsor: Naval Civil Engineering Laboratory

OBJECTIVE: Investigate the aerothermodynamics of test cell facilities using the PHOENICS computational fluid dynamics code, and assess the feasibility of using CDF codes in the design of test cells.

SUMMARY: NAVAIR has initiated a program for the modernization of existing test cell facilities and the design of new test cell facilities. The overall cost of the project is $700 million, with R&DT at $22 million. ONe part of the project is to determine the feasibility of using a computational fluid dynamics code to assist in the design of test cells. NPS is assisting the Naval Civil Engineering Laboratory in this effort. Over the past three years, six Naval officers at NPS have completed analyses of several test cells as this investigator made a presentation in London in 1987, and is expected to make a presentation in Brussels in 1990. The work to date has brought some understanding to a very complex problem. There is much evidence to conclude that CFD codes can be very effective tools in the design of future test cells.

THESES DIRECTED: T.G. Ratner, LT, "A Parametric Study of the Aerothermodynamics of a Jet Engine Test Facility," M.S., March 1989.

EFFECT OF BOW PLANES ON VORTICAL FLOW ABOUT SSN-21

T. Sarpkaya, Distinguished Professor of Mechanical Engineering
Sponsor: Defense Advanced Research Projects Agency

OBJECTIVE: The understanding of the vortices, internal waves, and the Bernoulli humps generated by the control planes and the hull of SSN-21.

SUMMARY: Extensive measurements were made through the use of an SSN-21 model in a towing tank to determine its wake characteristics. These were related to the dimensionless parameters such as the Reynolds number, Froude number, Brunt-Vaisala frequency, the angle of attack of the body and the bow planes, and the parameters characterizing the body shape. The investigation delineated the range of the angle of attack of the bow planes for which the vortex migration is limited to certain depths. The characteristics surface flow patterns resulting from the interaction of the internal waves with the free surface have been evaluated. Furthermore, means have been discovered to modify the shape of the fixed stability planes to practically eliminate the wake generated by them.

CONFERENCE PRESENTATION: T. Sarpkaya, "Discussion of the Numerical Prediction of the Hydrodynamic Characteristics of Submerged Bodies: Future Prospects in Submarine Technology," DARPA-ONT Meeting (SECRET), 6-9 November 1989.

EFFECT OF POROSITY ON THE COLLAPSE OF LARGE PARACHUTERS: ANALYSIS AND EXPERIMENTS

T. Sarpkaya, Distinguished Professor of Mechanical Engineering
Sponsor: Sandia National Laboratories

OBJECTIVE: To carry out a fundamental theoretical and experimental investigation of the effect of porosity on the collapse of large parachutes and to devise methods to prevent the collapse.

SUMMARY: Large parachutes, delivered by low flying, high speed aircraft, collapse shortly after the onset of deceleration. A fundamental investigation was undertaken through the use of the discrete vortex method. Extensive computer studies with (through the use of boundary-fitted vortices) and without the effect of porosity have shown that the cause of the collapse is the development of large vortices and their backward motion during the rapid deceleration of the parachute. Properly managed porosity can delay or prevent the consequences of wake-recontact. In addition, extensive tests were carried out in a vertical water tunnel. The measured forces and the flow kinematics agreed surprisingly well with those predicted numerically. The investigation has been extended to include the effect of porosity.

PUBLICATION: T. Sarpkaya, S.I.M. Mostafa, and P.D. Munz, "Numerical Simulation of Unsteady Flow About Cambered Plates," Journal of Aircraft, Forthcoming.

CONFERENCE PRESENTATION: S.I.M. Mostafa, T. Sarpkaya, and P. Munz, "Numerical Simulation of Unsteady Flow about Cambered Plates," 27th Aerospace Sciences Meeting of the American Institute of Aeronautics and Astronautics, Reno Nevada, AIAA Paper No: AIAA-89-0290, 10-14 January 1989.

SEPARATION POINTS ON A CYLINDER IN MULTI-FREQUENCY HARMONIC FLOW

T. Sarpkaya, Distinguished Professor of Mechanical Engineering
Sponsor: Chief of Naval Research

OBJECTIVE: To determine the excursion of the separation point on smooth and rough circular cylinders in multi-frequency harmonic flows (e.g., ocean waves which are composed of many amplitudes and frequencies). The unsteady flow used in this investigation is a generalization of a more special mono-harmonic flow. The latter is the subject of another investigation.

SUMMARY: Extensive experiments have been carried out in a U-shaped water tunnel The desired time-dependent flow is generated through the use of a Gaussian wave generator. The results will serve several purposes: 1) they will be compared with those obtained in the ocean environment; 2) they will enhance our knowledge of the most general separated oscillating flow about bluff bodies; and 3) they will help to device numerical methods to minimize the consequences of separation in bodies immersed in the ocean environment where the flow is not only omnidirectional, but also composed of many frequencies. The investigation in continuing through the use of several methods of separation-point identification (differential pressure probe, hot-film probe, and flow visualization) and through the use of several smooth and sand-roughened circular cylinders.

PUBLICATIONS: T. Sarpkaya, "Wave Forces on Cylindrical Piles," The sea, Vol. 9: Ocean Engineering Sciences, John Wiley & Sons, N.Y., pp. 169-195, 1989.

R. Budwig and T. Sarpkaya, "Time Dependent Flow About a Circular Cylinder," ONT-Fellow Final Technical Report to the Office of Naval Technology, Washington, DC, December 1989.

TWO AND THREE DIMENSIONAL VORTEX/FREE-SURFACE INTERACTIONS

T. Sarpkaya, Distinguished Professor of Mechanical Engineering
Sponsor: Chief of Naval Research (ONR)

OBJECTIVE: Basic research toward the understanding of the fundamental mechanisms and physical processes underlaying two and three dimensional vortex/free-surface interactions in homogeneous, stratified, and sheared media, taking into account ambient turbulence, viscous effects, and various large-scale instabilities (sinusoidal instabilities and vortex breakdown) for ship and submarine related hydrodynamics in a real ocean environment.

SUMMARY: Numerous numerical experiment have been carried out in a large towing tank with various lifting surfaces and submerged bodies in homogeneous and density-stratified medium. In addition, experiments with two-dimensional vortex pairs have been conducted in a large water basin using both stratified and homogeneous medium. The characteristics of the resulting surface scars have been evaluated in terms of the governing parameters through the use of a Motion Analysis System and a Sun computer. Extensive numerical analysis has been performed and a computer code has been developed to predict numerically the characteristics of the surface disturbances. Experiments and analysis are continuing towards the evaluation of the behavior of the scars in terms of the prevailing Froude numbers, Atwood numbers and the Vaisala-Brunt frequencies.

PUBLICATIONS: T. Sarpkaya, J. Elnitsky II, and R.E. Leeker, Jr., "Wake of a Vortex Pair on the Free Surface," Proceedings of the 17th Symposium of Naval Hydrodynamics, National Academy Press, pp. 53-60, 1989.

THESES DIRECTED: D.H. Rau, LT, USN "Free Surface Scars and Striations," M.S., June 1989.

DESIGN OF LAMINATED PLATES WITH BLADE-TYPE STIFFENERS

P.Y. Shin, Assistant Professor of Mechanical Engineering
Sponsor: NPS Research Council

OBJECTIVE: Composite Materials are ideal for structural applications where high strength-to-weight rations are required. Optimal design of the significant weight saving. The objectives of the research are to devise an adequate procedure for the optimal design with eigenvalue constraints and to apply the design procedure for design of a blade-stiffened laminated composite plate.

SUMMARY: An analysis code for composite plates is written in fortran language. The classical laminate theory is used to obtain flexural stiffness matrix and inplane stiffness matrix. These properties of the Laminate are incorporated into the system stiffness matrix using a sixteen degree of freedom rectangular finite element. The stiffener is assumed to be simply supported at 3 edges and free at one edge. Its analysis is simplified by using the levy's solution. The above computer program is used to find the optimal design using a nested approach in optimization which yields a system of nonlinear equations. These equations are then solved using the Homotopy method. Difficulty arises in Finding the solution due to multiplicity of eigenvalues of the optimal design. It is found the the Jacobian Matrix in the Homotopy Routine becomes ill-conditioned when the design becomes trimodal A unique mode does not exist for a design with repeated eigenvalues. A technique to separate these eigenvectors should be established.

CONDITION MONITORING AND DIAGNOSTICS OF SSBN 726 CLASS SUBMARINE TURBINE-DRIVEN TORPEDO EJECTION PUMPING SYSTEM (NEW PROJECT)

Y.S. Shin, Associated Professor of Mechanical Engineering
Sponsor: Naval Sea Systems Command

OBJECTIVE: To develop monitoring scheme and diagnostics method for non-stationary transient signatures and to apply for the turbine-driven torpedo ejection system of SSBN 726 Class Submarine.

SUMMARY: This is a new research project. The basis and applied research has been conducted to develop machinery condition monitoring techniques and diagnostic methods for the turbine-driven torpedo ejection pump (TEP). This research effort includes both analytical and experimental studies of transient and steady-state machinery noise and vibration signature analysis. It also includes such parameters as pressure and temperature. As the monitoring scheme is developed, testing will be performed using land-based TEP and NUSC, Newport, RI and actual operation of TEP aboard available submarine. A successful monitoring scheme will lead into the diagnostics method and subsequently recommendation for design modification will be made to prolong the design life of the pump. Currently, we are developing the 3-dimensional time dependent spectrum called Wigner Distribution to characterize the non-stationary transient signatures typical of TEP system. The results of this research will be extremely useful to prevent any catastrophic failure of TEP system and will save US Navy the time and cost of unnecessary periodic maintenance.

DYNAMIC RESPONSE AND FAILURE OF COMPOSITE AND METAL PANELS TO UNDERWATER SHOCK LOADS

Y.S. Shin, Associate Professor of Mechanical Engineering
Sponsor: Defense Nuclear Agency

OBJECTIVE: To advance our understanding on shock induced dynamic behavior and failure mechanism of composite structures through the analytical studies and the underwater explosion testings.

SUMMARY: The composite materials have been extensively used in many defense projects. However, their dynamic characteristics in underwater shock environment are not well understood. In this research project, experimental and analytical studies were performed to gain the insight into the shock induced dynamic behavior and failure mechanism of composite structures using circular flat panel models made of S-2 glass fiber polyester rasin composites and aluminum. Six underwater explosion tests were performed at Hunter's Point Naval Shipyard in South San Francisco. The types of failure modes observed include matrix cracking, fiber breakage, shear rupture, and delamination. The dynamic behavior of composite panels was distinctively different from that of aluminum panels. The bending and memberance stiffness coupling was extremely higher than the case of aluminum, which makes the composite much more resistive in hostile environment. The results of this research efforts are being contributed for the better use of composite materials to submarine applications such as sonar dome, external flaring, and to the surface ship components exposed directly to shocks such as mine sweepter.

PUBLICATIONS: K.S. Kim and Y.S. Shin, "Application of a New Hilbert Transform Method for Nonlinear Identification," Proceedings of the 7th International Modal Analysis Conference, Las Vegas, pp. 1386-1393, January 30 - February 2, 1989.

CONFERENCE PRESENTATION: K.S. Kim and Y.S Shin, "Application of a New Hilbert Transform Method for Nonlinear Identification," Presented at the 7th International Modal Analysis Conference, Las Vegas, January 30 - February 2, 1989.

SUBMARINE-INSTALLED MACHINERY NOISE MONITORING AND DIAGNOSTICS

Y.S. Shin, Associate Professor of Mechanical Engineering
Sponsor: Defense Advanced Research Projects Agency

OBJECTIVE: 1) To perform the extensive state-of-the-art review on submarine-installed machinery condition monitoring, diagnostics and noise reduction techniques to identify and discuss existing methods, their limitations, and base technology needs; and 2) to investigate the statistical approach for gear fault detection scheme.

SUMMARY: A need to accurately assess submarine-installed machinery conditions is essential to prevent unexpected catastrophic failures causing critical problems in the operation of submarines. The vibration and noise generated by the machine are commonly used to reveal its machinery condition. The current practice in submarine-installed machinery diagnostics reveals that the machinery conditions are predicted based on the vibration measurement by single transducer at various pick-up locations (usually in radial and axial direction). The current measured data are compared with the past histories to observe the trending, any unusual vibration behavior is identified and the measured data are evaluated quantitatively. The results of this research have clearly identified the problem areas in submarine-installed machinery condition monitoring and diagnostics, and future directions. This research has led to the sponsored research on "monitoring Scheme and Diagnostics Method for Non-stationary Signals: Turbine-driven Torpedo Ejection Pumping System for Trident Class Submarines.

THESIS DIRECTED: J.D. Robinson, LT, USN, "Machinery Vibration Analysis Using Statistical Parameters of the Time Domain Signal," M.S., December 1989.

VIBRATION DAMPING-DESIGN ANALYSIS AND TESTING

Y.S. Shin, Associate Professor of Mechanical Engineering
Sponsor: David Taylor Research Center

OBJECTIVE: To develop the highly damped passive vibration control devices or treatment to the primary structures and to apply for critical Naval components for ship silencing.

SUMMARY: This research work is for continuation of on-going research in vibration damping. The control of vibration of a mechanical system is usually accomplished by both active and passive devices or treatment to the structures. In this continuing project, the passive device and treatment to the system have been a concern to control the vibration in form of energy dissipation, isolation, and absorbing devices. The application of concept of combining the constrained viscoelastic layers, tuned dampers, and waveguide absorbers to Naval components are explored to effectively introduce the significant damping into the system. The results of on-going research have given significant contributions to improve the design of the critical Naval components (classified) from the standpoint of ship silencing. It gave the direct impact on the design concept and philosophy of the critical component (classified) in SSN21 attack submarine.

PUBLICATIONS: Y.S. Shin and G.J. Maurer, "Vibration Response of Constrained Viscoelastically Damped Plates: Analysis and Experiments," Proceedings of the 7th International Modal Analysis Conference, Las Vegas, pp. 1516-1520, January 30 - February 2, 1989.

C.D. Hettema, Y.S. Shin, and K.S. Kim, "Analysis of Circular Viscoelastic Waveguide Absorber," ASME PUBLICATION DE-Vol. 18-1, Machinery Dynamics Application and Vibration Control Problems, Presented at the ASME Vibration Conference, Montreal, Canada, pp. 263-273, September 17-20, 1989.

Y.S. Shin, J.C. Iverson, and K.S. Kim, "Experimental Studies on Damping Characteristics of bolted Joints for Plates and Shells," ASME Publication PVP-Vol. 158, Advances in Bolted Joint Technology - 1989, Presented at the ASME Pressure Vessel and Piping Technology Conference, Honolulu, Hawaii, pp. 105-113, July 23-27, 1989.

CONFERENCE PRESENTATIONS: Y.S. Shin and G.J. Maurer, "Vibration Response of Constrained Viscoelastically Damped Plates: Analysis and Experiments," Presented at the 7th International Modal Analysis Conference, Las Vegas, January 30-February 2, 1989.

C.D. Hettema, Y.S. Shin, and K.S. Kim, "Analysis of Circular Viscoelastic Waveguide Absorber," Presented at the ASME Vibration Conference, Montreal Canada, September 17-20, 1989.

Y.S. Shin, J.C. Iverson, and K.S. Kim, "Experimental Studies on Damping Characteristics of Bolted Joints for Plates and Shells," Presented at the ASME Pressure Vessel and Piping Technology Conference, Honolulu, Hawaii, pp. 105-113, July 23-27, 1989.

THESIS DIRECTED: S.J. Watson, LT, USN "Experimental Studies of Circular Waveguide Absorbers for Passive Structural Damping," M.S., December 1989.

TURBULENCE STRUCTURAL CHARACTERISTICS OF FILM COOLING JETS WITH AND WITHOUT INTERACTIONS EMBEDDED LONGITUDINAL VORTICES IN TURBULENT BOUNDARY LAYERS

C.S. Subramanian, Adjunct Research Professor Mechanical Engineering
P.M. Ligrani, Associate Professor Mechanical Engineering
Sponsor: None

OBJECTIVE: To survey and study the Reynolds stress tensor components and turbulent transport triple products resulting from the presence of film cooling injection in turbulent boundary layers both with and without interactions with embedded longitudinal vortices.

SUMMARY: The vortex is produced in a zero-pressure gradient turbulent boundary layer using a half delta wind on the wind tunnel floor at a location 63 injection hole diameters upstream of the injection site. The single, circular wall jet is included at 30 degrees to the horizontal. Vortex circulation is 0.085 m2/s 41.9 diameters downstream of injection holes. With the jet opposing the vortex downwash and the blowing ration increasing from 0 to 4.8, maximum streamwise vorticity decreases from 750 to 150 s-1, while circulation decreases from 0.148 to 0.05 m2/s. For a 1.5 flowing ratio, the six Reynolds stress components and associated triple products are altered significantly in the embedded vortex because of the presence of the wall jet. Because of the jet, the longitudinal and spanwise normal Reynold stress components are increased in the vortex upwash. Changes due to the jet are smaller in the vortex core and downwash region. Reynolds shear stress components indicate regions of negative production ear the vortex core which are more intense with a blowing ratio of 15. than with zero injection. This situation also gives stress gradients which are severely distorted by the jet beneath the vortex core.

PUBLICATIONS: P.M. Ligrani and G.W. Schwartz, "Control of Embedded Longitudinal Vortices Using a Wall Jet, American Institute of Aeronautics and Astronautics Journal, Submitted.

C.S. Subramanian, P.M. Ligrani, J.G. Green, and W.D. Doner, "Turbulence Structure of Embedded Vortex/Wall Jet Injection in a Turbulent Boundary Layer," Journal of Fluid Mechanics, Submitted.

DEPARTMENT OF METEOROLOGY

DEPARTMENT OF METEOROLOGY

The research program in the Department of Meteorology continues in several areas: (1) numerical air/ocean modeling and prediction, (2) dynamics of fronts and flow over and around mountains, (3) analysis and dynamics of tropical weather systems, (4) analysis and dynamics of midlatitude weather systems, (5) atmospheric boundary layers over the sea and ice, (6) regional weather studies and (7) remote sensing. A number of related investigations have been pursued by various faculty members under each of these headings.

NUMERICAL MODELING AND PREDICTION

R. T. Williams is developing and testing numerical procedures for global and regional weather prediction. He is investigating various finite element and semi-Lagrangian formulations with respect to treatment of small-scale flow fields. He is also applying the techniques to the prediction of cyclogenesis. R. T. Williams, C.-P. Chang and M. S. Peng are investigating the "Mei-Yu" front over eastern Asia with a dynamical front model.

R. L. Elsberry and L. K. Shay are using a three-dimensional ocean model to simulate the response to passage of a hurricane. The present focus is on comparing the predicted response to recent observations of currents and temperature in the ocean after hurricane passage.

Numerical-observational studies of rapid maritime cyclogenesis events are being pursued by R. L. Elsberry, C.-S. Liou, W. A. Nuss and C. H. Wash. Diagnostic studies of analyses and predictions by the Naval Operational Regional Atmospheric Prediction System (NORAPS) are used to evaluate physical processes that occur during rapid cyclogenesis. R. L. Elsberry and C.-S. Liou are also investigating methods to improve the NORAPS performance in analyzing and predicting cyclogenesis. P. Harr is examining a large set of global model predictions to identify error tendencies in the forecasts of maritime cyclone intensities and positions.

J. W. Glendening is employing a finite-element model for the atmospheric boundary layer using second-order closure to predict turbulence production and transport, to analyze boundary layer structure and its temporal and spatial variation in the arctic marginal ice zone. In addition, he is employing large-eddy closure techniques to study boundary layer development in the strongly baroclinic zone above and down wind of arctic leads.

T. R. Holt is examining the importance and sensitivity of boundary layer parameterizations in a three-dimensional mesoscale model for simulations of coastal cyclogenesis. The present focus is on the simulation of the low level jet and the effects of the jet on turbulent exchanges in the baroclinic boundary layer due to strong shear instability. In addition, the effects of differential surface friction and temperature across the land/sea interface are also being examined.

W. A. Nuss is investigating the role of boundary layer processes in frontogenesis and cyclogenesis over the ocean using the NCAR/Penn State mesoscale model. Diagnostic studies of the model predictions are used to evaluate the alteration of baroclinic processes by surface forcing. Observational studies of these processes are also being performed using aircraft data taken during ERICA.

Other modeling efforts include (1) a marine atmospheric boundary layer model for predicting (6-12 hours) properties that affect radar and optical propagation within the boundary layer, and those factors (radiation and boundary fluxes) that affect the upper part of the ocean, directed by K. L. Davidson, and (2) a numerical investigation of the dynamics and prediction of synoptic-scale variability in the coastal ocean off California, led by R. L. Haney.

DYNAMICS OF FRONTS AND FLOW OVER AND AROUND MOUNTAINS

R. T. Williams is studying the conditions that determine whether or not the air will flow over or around a long mountain range. The formation of cyclones in the lee of mountain complexes is being investigated. Also, R. T. Williams and M. S. Peng are studying the interaction of fronts with topography, and R. L. Haney is investigating the effects of topography and baroclinity in the coastal ocean circulation.

ANALYSIS AND DYNAMICS OF TROPICAL WEATHER SYSTEMS

C.-P. Chang, R. T. Williams, J.-M. Chen and M. S. Peng continue to investigate various aspects of the dynamics tropical synoptic and planetary motions, and tropical mid-latitude interactions. The diagnostic analysis of east tropical weather systems is being pursued by C.-P. Chang and J.-M. Chen.

A multi-year basic research program to understand the dynamics of tropical cyclone motion has begun. R. L. Elsberry serves as the Technical Director of the overall research initiative for the Office of Naval Research. R. T. Williams and M. S. Peng are developing analytical and numerical models of tropical cyclone motion. R. L. Elsberry and associates continue applied research efforts to improve tropical cyclone prediction via statistical evaluations and expert systems.

ANALYSIS AND DYNAMICS OF MIDLATITUDE WEATHER SYSTEMS

Observational studies of rapid maritime cyclogenesis events are being pursued by W. A. Nuss and C. H. Wash. Operational and special experimental data taken during the ERICA field program are used to diagnose the structure and physical processes that contribute to the rapid development of oceanic cyclones. W. A. Nuss is also studying the development of several cyclones along the coast of Japan.

ATMOSPHERIC BOUNDARY LAYERS OVER THE SEA AND ICE AND IN THE COASTAL ZONE

Research in this area includes several interdisciplinary shipboard and land-based observational and theoretical projects involving K. L. Davidson, W. J. Shaw, P. S. Guest and a Ph. D. student. Extensive sampling of surface layer and boundary layer properties during the arctic night and into a period of total sunlight was conducted near

Svalbard Island Sep 88 - May 89. Measurements were made from ships and ice camps and aircraft (NOAA P-3). Interpretations are being made and papers are being prepared on these experiments and on data collected in the vicinity of a SST front in the west North Atlantic early in 1986 and in the English Channel late in 1986. Objectives of the individual projects are: (1) to evaluate and formulate models that relate changes in the depth and structure of the atmospheric boundary layer to surface fluxes and sky conditions, (2) to evaluate and formulate models for equilibrium marine aerosol distributions, (3) to establish synoptic-scale descriptions of the magnitude and height variations of optical turbulence, and (4) to evaluate synoptic-scale forcing on the boundary layer processes and evolutions in the marginal ice zone, (5) to improve the specifications of momentum and maritime flux at the air-sea interface and determine its influence on the overlying atmosphere.

W. J. Shaw continued investigations of mesoscale variability in the coastal and marine atmospheric boundary layers. Aircraft data collected aboard the NCAR Electra research aircraft in the Sargasso Sea and aboard the NOAA P-3 research aircraft in the East Greenland Sea are being analyzed to determine the mechanisms involved in the response of the atmosphere to mesoscale variability of surface forcing. W. J. Shaw, K. L. Davidson and P. A. Durkee are analyzing data from a measurements program with NEPRF (now NOARL) and NOAA's Wave Propagation Laboratory in the sea-breeze circulation in the Salinas Valley, California. This study involved acoustic sounders,, surface measurements, rawinsondes and doppler lidar in one of the most extensive sea-breeze measurement experiments that has been undertaken.

REGIONAL WEATHER STUDIES

F. R. Williams and R. J. Renard completed and published (under NOARL auspices) a Forecaster's Handbook for Central America and adjacent ocean areas that includes sections on climatology, air/ocean circulations and thermal features that are important to naval air/sea operations. The 508-page handbook includes case studies of hurricanes striking Central America during 1988--the first to do so since 1980. A study similiar to that for Central America is underway for the Philippines and adjacent waters.

REMOTE SENSING

P. A. Durkee is examining the relationship between satellite-detected visible and infrared radiance and extinction by aerosols. The effects of aerosols on cloud brightness and subsequent radiative effects are also being studied. In addition, P. A. Durkee is participating in the Stratospheric Aerosol and Gas Experiment (SAGE III). C. H. Wash and P. A. Durkee continue to explore methods of using multi-channel satellite data to objectively classify clouds.

K. L. Davidson is involved in experimental verification on mechanisms responsible for scatterometer and synthetic aperture radar (SAAR) images of the ocean surfaces. Analyses were completed on surface stress data from a tower off the coast of California near San Diego and were collected in conjunction with aircraft and tower radar measurements. In another experiment off the Norwegian west coast surface wind stress measurements were made during moderate to high winds from a buoy as well as a ship. The ship also had a three wavelength (L-,C- and X-band) scatterometer onboard and, distributed over the region, was a quite extensive wave and current measurement system. This was a high wind and high sea-state experiment.

TROPICAL AND MONSOON STUDIES

C.-P. Chang, Professor of Meteorology
R.T. Williams, Professor of Meteorology
M.S. Peng, Adjunct Research Professor
J.M. Chen, Adjunct Research Professor
H. Lim, Adjunct Research Professor
Sponsor: National Science Foundation

OBJECTIVE: To study the structure and dynamics of large-scale motions in the topics and monsoon regions, including their interaction with motions in the extratropics.

SUMMARY: This project includes three major components in the study of tropical and monsoon dynamics: 1) theoretical and modeling studies of planetary scale motion forced by tropical heating; 2) observational studies of planetary and synoptic scale motion related to tropical forcing and midlatitude-tropical interactions, and 3) numerical simulation of the Mei-Yu system of the East Asian summer monsoon and the effect of topography on fronts. In the first component, a nonlinear CISK model was formulated in a two-dimensional Kelvin wave framework. The numerical integration of spectral model shows that even though the rising branch of the CISK motion is concentrated in a narrow band, the sinking motion spreads over a much larger area. A nonlinear mode is definable with a steady organized circulation structure and constant exponential growth rate. The spatial scale is larger for slower growth. In the second component, a 14-year global band tropical data set is used to study the extratropical vorticity response to equatorial divergent forcing. The sensitivity of the response to the location of the forcing was determine through successive base point correlations between tropical divergence and global vorticity parameters. In the third component, the NRL regional model is installed at NCAR computer to prepare for a study of the effect of topography on frontogenesis.

PUBLICATIONS: H.Lim, T.K. Lim, and C.-P. Chang, "Re-examination of Wave-CISK Theory: Existence and Properties of Nonlinear Wave CISK Modes," J. Atmospherica Sci., (Under Revision).

H. Lim, T.K. Lim, and C.-P. Chang, "Vertical Wind Shear Effects on Nonlinear Kelvin Wave-CISK Modes: Possible Relevance to 30-60 Day Oscillations," Papers in Meteorological Research, (Submitted).

C.P. Chang, M.S. Peng, and J.S. Boyle, "interannual Variations of Tropical Divergent and Rotational Motions in the Upper Troposphere during Northern Winter," Proceedings 18th Conference on Hurricanes and Tropical Meteorology, May 3-4, 1989.

M.S. Peng, and A.Z. Loesch, "Spectral Evolution of Baroclinic Waves in Continuously Stratified Eady Model with Ekman Dissipation," European Journal of Mechanics, B/Fluid, 8, 441-455.

CONFERENCE PRESENTATIONS: C.P. Chang, M.S. Peng, and J.S. Boyle, "Interannual Variations of Tropical Divergent and Rotational Motions at 200 mb During Northern Winter," 18th Conference on Hurricanes and Tropical Meteorology, American Meteorological Society, San Diego, May, 1989.

C.P. Chang, "A Numerical Study of Mei-Ye Front," International Conference on East Asia and West Pacific meteorology and Climate, Hong Kong, July, 1989.

H. Lim, T.K. Lim and C.P. Chang, "Effects of Vertical Wind Shear on Kelvin Wave CISK Modes," International Conference on East Asia and West Pacific Meteorology and Climate, Hong Kong, July, 1989.

H. Lim, T.K. Lim, and C.P. Chang, "Nonlinear Kelvin Wave-CISK Modes and 3-60 Day Oscillations," IAMAP General Assembly, Reading, U.K., August, 1989.

WIND ANALYSIS OVER TROPICAL OCEANS DURING TOGA

C.-P. Chang, Professor of Meteorology
M.S. Peng, Adjunct Research Professor of Meteorology
Sponsor: National Oceanic and Atmospheric Administration

OBJECTIVES: To study the feasibility of using satellite cloud-derived winds to enhance surface analysis over the tropical Pacific during the Tropical Ocean and Global Atmosphere Experiment and to study the effect of tropical sea surface temperature on global circulations.

SUMMARY: The satellite low level cloud drift winds during April-June 1984 were used to reanalyze the monthly mean surface marine winds over the tropical Pacific. The surface 850 mb wind shear based on FNOC operational products was used to project the satellite winds. Experiments were conducted to evaluate the error of analysis based on actual observations. Inerating methods with bias correction were designed and tested to minimize the errors. The total domain of the tropical Pacific was divided into sub-regions to evaluate errors due to direction and speed bias of the low-level satellite winds. It was found that with 3-4 iterations of bias corrections, the errors in the equatorial Western Pacific can be reduced to around 2 m/s.

THESIS DIRECTED: Derek Hee, LT, USN, "Reanalysis of Tropical Pacific Surface Marine Winds using Low-Level Cloud Drift Winds," M.S. Thesis, September, 1989.

REMOTE SENSING AND AIR SEA INTERACTION

K.L. Davidson, Professor of Meteorology,
P. Durkee, Associate Professor of Meteorology and
C. Skupniewicz, Physical Scientist
Sponsor: Office of Naval Research (ONR-112D1)

OBJECTIVE: Current objectives in these continuing studies were to: 1) Interpret tower/shipboard obtained wind stress values collected in the FASINEX and NORCSEX experiments with regard to the influence of local SST and wave features and to combine them with radar obtained results 2) perform analyses on surface wind stress obtained from a ship and a buoy in NORCSEX (March-April 1988) and from a tower and a buoy in the SAXON (September-October 1988) experiment.

SUMMARY:CY 89 efforts for remote sensing were to perform preliminary joint analyses on data collected in the NORCSEX experiment of 1988 and to perform analyses and interpretations of data collected in the SAXON experiment conducted at the Chesapeake Light Tower (CLT) near Norfolk, Virginia. NORCSEX surface wind stress measurements are larger in some cases than those predicted by existing wind speed and stability dependent formulations (e.g. JGR, Geernaert 1987 and Smith 1988). Considerable attention was given in FY89 to the relationship between shipboard wind stress and scatterometer measurements. These analyses have progressed to a multi-author publication being complete. NORCSEX 10 meter equivalent wind speeds, adjusted for stability using measured friction velocities, and ship mounted scatterometer values show best fit relations with two linear segments. The sub groups correspond to wind speeds less than 6 m/s and greater than 8 m/s.

PUBLICATIONS: Geernaert, G.L., K.L. Davidson, S.E. Larsen and T.M. Mikkelson, 1988; "Wind Stress Measurements During the Tower Ocean Wave and Radar Dependence Experiment," Journal Geophysical Research, 93, 13913-13924

Li, F., W. Large, W.Shaw, E. Walsh and K. L.Davidson, 1989; Ocean Radar Backscatter Relationships With Near Surface Winds: A Case Study During Fasinex," Journal of Physical Oceanography,19, 342-353.

Onstott, R.G., R.A. Shuchman, K.L. Davidson, J.A. Johannessen and O. Skagseth, 1989: Scatterometer Measurements of the Ocean and Ocean Fronts during NORCSEX," Proceedings, IGARSS'89/12th Canadian Symposium on Remote Sensing, NORCSEX Session, Vancouver, B.C., Canada, 10-14 July 1989, 1084-1088.

Skupniewicz,C.E. and K.L.Davidson, 1989; "Deployment of a Near-Surface Flux Buoy During NORCSEX," Journal of IEEE,(special IGARSS '89 issue), Submitted.

K.L.Davidson, R.G. Onstott, R.A. Shuchman,J.A. Johannessen and O. Skagseth, "Surface Wind Stress and Radar Scattering Coefficient Variations in the Vicinity of an Atmospheric Storm and an Ocean SST Front," Journal of Geophysical Research, Submitted.

J.A.Johannessen, R.A. Shuchman,K.L.Davidson and O.A. Johannessen , 1989: "Detection of Meso-Scale Currents and Wind Shifts from ERS-1," Journal of Geophysical Research, Submitted.

CONFERENCE PRESENTATIONS: Onstott, R.G., R.A. Shuchman, K.L. Davidson, J.A. Johannessen and O. Skagseth, 1989: Scatterometer Measurements of the Ocean and Ocean Fronts during NORCSEX," Proceedings, IGARSS'89/12th Canadian Symposium on Remote Sensing, NORCSEX Session, Vancouver, B.C., Canada, 10-14 July 1989.

Trizna, D.B. and K.L. Davidson, 1989: "Correlation of Marine Radar Cross Section Statistics with Wind Stress during NORCSEX," IGARSS' 89/12th Canadian Symposium on Remote Sensing, NORCSEX Session, Vancouver, B.C., Canada, 10-14 July 1989.

Davidson, K.L., C. Skupniewicz and O. Skagseth, 1989: "NORCSEX Wind Stress Measurements From a Ship and a Buoy," IARSS'89/12th Canadian Symposium on Remote Sensing, NORCSEX Session, Vancouver, B.C., Canada, 10-14 July 1989.

Geernaert, G.L, K.L. Davidson and S. Hanson, 1989: "Wind Stress Vector Measurements during SAXON," IGARSS'89/12th Canadian Symposium on Remote Sensing, SAXON Session, Vancouver, B.C., Canada, 10-14 July 1989.

ATMOSPHERIC FORCING IN OCEAN-ATMOSPHERE MIXED LAYER PROCESSES AND HUMIDITY TRANSFER

K. L. Davidson, Professor of Meteorology,
W.J. Shaw, Associate Professor of Meteorology and
P.J. Boyle, Meteorologist
Sponsor: Office of Naval Research (ONR-1122PO,-1122MM)

OBJECTIVES: Current objectives in these continuing studies are to complete coordinated (with other platform groups) analyses and interpretations of atmospheric surface and boundary layer data obtained in the Frontal Air Sea INteraction EXperiment (FASINEX) and in the Humidity EXchange MAin eXperiment (HEXMAX).

SUMMARY: FASINEX: FY89 efforts have been directed toward analyses and interpretations of data for chapters in a FASINEX monograph (J.Geophys. Res., special Issue). Analyses in FY89 have led to the conclusion that the composite of FASINEX shipboard measured surface wind stress results are in agreement in terms of the wind speed dependence of the neutral drag coefficient (Cdn), with the open ocean results described by Smith (1988). However, non-composite results also show the existence of wave and swell influence in the vicinity of atmospheric storm fronts. This was first shown for FASINEX in an M.S. thesis Mundy (1987) and is now being prepared for several Journal articles. FY89 accomplishments for HEXMAX related to the completion of analyses on dissipation derived wind stress results obtained on the RRS Frederick Russell and comparisons of these with both dissipation and eddy correlation derived results obtained on the MPN platform.

PUBLICATIONS: de Leeuw, G. and K.L. Davidson, "Mixed-Layer Profiling with Lidar and Modeling of the Aerosol Vertical Structure," Journal of Atmospheric and Oceanic Technology, (Submitted 7 December 1988) revised April 1989

Davidson,K.L, P.Boyle, C.Gautier, H.Hanson, S. Khalsa and D. Rogers, 1989: "Descriptive Meteorology During FASINEX, Medium to Large Scale Variability," Journal of Geophysical Research, (special FASINEX issue) Submitted.

Friehe, C., W.J.Shaw, D. Rogers, K.L.Davidson, W.Large, G. Crescenti, S.Stage, 1989: "Air-Sea Fluxes and Surface Layer Turbulence Around a Sea Surface Temperature Front," Journal of Geophysical Research (special FASINEX issue) Submitted.

Geernaert, G.L. K.L. Davidson and P.S. Guest, Observed Short-term Characteristics of the Marginal Ice Zone Planetary Boundary Layer and its Impact on Elevated EM Ducting, Radio Science, (in progress)

Li,F., W. Large, W.Shaw, E. Walsh and K.L. Davidson, 1989; Ocean Radar Backscatter Relationships With Near Surface Winds: A Case Study During Fasinex," Journal of Physical Oceanography, 19, 342-353.

Stage, S., W.J. Shaw, G. Crescenti, K.L. Davidson, C.Gautier, G. Greenhut, S. Khalsa, M-K Wai, 1989: "Response of the Atmosphere to Oceanic Fronts," Journal of Geophysical Research, (special FASINEX issue) Submitted.

CONFERENCE PRESENTATIONS: Davidson, K.L., C. Skupniewicz and G. de Leeuw, 1989: "Shipboard Wind and Humidity Turbulence Results - HEXMAX, "IAMAP 89/Symposium on Global Energy and Water Fluxes, Special session on Evaporation and Energy Fluxes from the Ocean, University of Reading, Reading U.K., 31 July - 12 August 1989.

METEOROLOGICAL STUDIES OF ARCTIC REGIONS

K.L. Davidson, Professor of Meteorology,
W.J. Shaw, Associate Professor of Meteorology and
P.S. Guest, Meteorologist
Sponsor: Office of Naval Research (ONR-1125AR, 1244)

OBJECTIVE: Objectives were to make progress on analyses/ interpretations of meteorological data collected in two Marginal Ice Zone EXperiments (MIZEX-84 and -87), to collect and to perform preliminary analyses on data form the Coordinated Eastern ARctic EXperiment (CEAREX).

SUMMARY: Shipboard and ice camp measurements were made of surface layer meteorology and aerosol parameters through April 1989 in CEAREX. Surface wind stress and rawinsonde data were collected from the R/V's Polarbjoern and Haakon Mosby during the January-April and February-March periods, respectively. Similar measurements were made from two ice camps, the "acoustics" and the "oceanographic" camps during the last week of March and through April. Data atlases were prepared (Lackmann et al. and Guest and Davidson) on the type of data collected with time series and vertical profile plots. Analyses efforts during the fall quarter have been directed toward the CEAREX workshop to be held in Gulfport,MS during the first week of February 1990 and to the AGU Ocean Sciences meeting to be held in New Orleans during the second week of February. Current interpretations are on the role of advection on establishing the equilibrium temperature profiles observed from the Polarbjern during the end of the November-December 1989 CEAREX drift period. Composite interior to the ice edge and ice edge rawinsonde profiles are being formed to establish the roles of ice edge and lead features on the equilibrium conditions.

PUBLICATIONS: Shaw, W.J., K. L. Davidson. Z. Willis, and D. Groters, "Horizontal Variability of Mean Refractive Structure in the Arctic." Proceeding Conference on Microwave Propagation in the Marine Boundary Layer (NEPRF), Monterey, CA. September, 1988 (1989) Forthcoming.

Francis, J.A., T.P.Ackerman, K.B.Katsaros, K.L. Davidson and R.J. Lind, "A Summer Radiation Budget for the Fram Strait Marginal Ice Zone," Journal of Climate, Forthcoming.

Geernaert, G.L. K.L. Davidson and P.S. Guest, Observed Short-term Characteristics of the Marginal Ice Zone Planetary Boundary Layer and its Impact on Elevated EM Ducting, Radio Science, In Progress.

Guest, P.S., K.L. Davidson, 1989; "CEAREX/"O" and "A"Camp," NPS 63-89-007, p. 65.

Lackmann, G.M., P.S. Guest, K.L. Davidson, R.J. Lind, J. Gonzalez, 1989: "CEAREX/ POLARBJOERNMeteorologyAtlas,"NPS-63-89-005, p 550.

CONFERENCE PRESENTATIONS: Davidson, K.L., 1989: "Meteorological Scientific Questions in the CEAREX 9-month Experiment," DOD Arctic Science and Engineering Conference, Cold Regions Research and Engineering Laboratory (CRREL),Hannover, NH, 21-23 June 1989.

Davidson, K.L.,1989: "Results From MIZEX and CEAREX and the Implications for ARCTIC LEADS," NOARL-west ,Monterey, CA ,October, 1989.

AEROSOL PROPERTIES OF THE MARINE ATMOSPHERIC BOUNDARY LAYER

K.L.Davidson, Professor of Meteorology,
P. A. Durkee, Associate Professor of Meteorology,
W.J. Shaw, Associate Professor of Meteorology
Sponsor: Naval Ocean Systems Center (Code 54)

OBJECTIVE: Objectives of analyses/interpretations and data collection in these continuing studies were to verify or formulate equilibrium marine aerosol models for, a) vertical variation in overwater regimes of mid and subtropical regions and b) surface layer as influence by advection in Marginal Ice Zone (MIZ) region.

SUMMARY: Evaluations of the Navy Oceanic Vertical Aerosol Model (NOVAM) were made with rawinsonde and aerosol data collected during three days of the FIRE experiment in 1987. Further analysis and data matching are being performed on the remaining eight days of the experiment. Documentation and conference presentations of the status of NOVAM and of the evaluation results were made at four different national and international meetings. Aerosol data were collected during a three-week period on an ice camp, the "acoustics" camp, located well within the arctic ice pack in CEAREX. Plans have been established for a sub-tropical vertical aerosol experiment in FY 1991.

PUBLICATIONS: Davidson, K.L., G. de Leeuw, S.G. Gathman and R.R. Jensen (1989). Verification of the Navy Oceanic Vertical Aerosol Model during FIRE. FIRE Science Meeting, Monterey, CA, July 10-14, 1989, NASA Conference Publication, in preparation.

de Leeuw, Gerrit and K.L. Davidson (1989). Mixed-layer Profiling with Lidar and Modeling of the Aerosol Vertical Structure. Submitted to J. Atmos Oceanic Techn. (7 Dec. 1988), revised April 1989.

de Leeuw, Gerrit, K.L. Davidson, S.G. Gathman and R.V. Noonkester, 1989: "Physical Models for Aerosol in the Marine Mixed-Layer," Proceedings, 44th Symposium of the Electromagnetic Propagation Effects, AGARD CP 453, San Diego, Ca, 15-19 May 1989, 40-1 to 40-8.

de Leeuw, Gerrit and K.L. Davidson 1989;"Aerosol Modeling in the Marine Atmospheric Boundary Layer," 8th World Clean Air Congress, The Hague, The Netherlands, September 11-15, 1989; vol 3. Elsevier Science Publ. B.V. Amsterdam , L.J. Brasser and W.C. Mulder (Eds), 617-622.

de Leeuw, Gerrit, K.L. Davidson, S.G. Gathman and R.V. Nookester, 1989; "Modeling of Aerosols in the Marine Mixed-Layer," SPIE Proceedings Volume 115 SPIE Conference on "Propagation Engineering," Orlando, FL, USA, March 27-31, 1989, 1115-1127.

de Leeuw, Gerrit., K.L. Davidson, S.g. Gathman and D. Jensen, 1989; "The Naval Oceanic Vertical Aerosol Model: Progress Report," Proceedings, AGARD Electromagnetic Wave Propagation Panel Symposium on "Atmospheric Propagation in the UV, Visible, IR and mm-wave Region and Related Systems Aspects," Copenhagen, Denmark, 9-13 October, 1989, 17-1 to 17-11.

CONFERENCE PRESENTATIONS: de Leeuw, G., K.L. Davidson, S.G. Gathman and R.V. Noonkester (1989): "Modeling of Aerosols in the Marine Mixed-Layer," SPIE Proceedings Volume 1115, SPIE Conference on "Propagation Engineering," Orlando, FL, 27-31 March, 1989 pp.

de Leeuw, Gerrit., K.L. Davidson, S.G. Gathman and R.V. Noonkester (1989): "Physical Models for Aerosols in the Mmarine Mixed-Layer," AGARD Electromagnetic Wave Propagation Panel Specialists' Meeting on "Operational Decision Aids for Exploiting or Mitigating Electromagnetic Propagation Effects, San Diego, CA, 15-19 May, 1989.

Davidson, K.L., G. de Leeuw, S.G. Gathman and R.R. Jensen (1989). Verification of the Navy Oceanic Vertical Aerosol Model during FIRE. FIRE Science Meeting, Monterey, CA, July 10-14, 1989,

de Leeuw, G., and K.L. Davidson (1989): Aerosol Modeling in the Marine Atmospheric Boundary Layer. 8th World Clean Air Congress, The Hague, The Netherlands, September 11-15, 1989; (to appear) Elsevier.

de Leeuw, G., K.L. Davidson, S.G. Gathman and D. Jensen (1989): The Naval Oceanic Vertical Aerosol Model: Progress Report. AGARD Electromagnetic Wave Propagation Panel Symposium on "Atmospheric Propagation in the UV, Visible, IR and mm-Wave Region and Related Systems Aspects,"Copenhagen, Denmark, 9-13 October, 1989.

SATELLITE INVESTIGATIONS OF AEROSOL PARTICLE DISTRIBUTIONS ASSOCIATED WITH DMS AND THEIR RELATIONSHIP TO MARINE CLOUD CHARACTERISTICS

Philip A. Durkee, Associate Professor of Meteorology
Sponsor: NASA

OBJECTIVE: The relationship between oceanic dimethyl sulfide (DMS) emissions, atmospheric aerosol production and cloud reflectance will be examined using satellite estimates of cloud and aerosol characteristics. Global to regional scale analyses will be performed and compared to known sources of DMS. This work will also support field programs planned under the Pacific Stratus/Sulfur Investigations.

SUMMARY: This project was designed as a three-year project sponsored by an interdisciplinary NASA program. A pilot field experiment was conducted off the coast of Washington in April 1989 and will be repeated in 1990. Ship, aircraft and satellite based observations are being compared to investigate the role of aerosols and clouds in climate. Also, global summaries of aerosol and cloud properties are being produced to investigate global-scale processes.

CONFERENCE PRESENTATIONS: Durkee, P. A., 1989: Global and Regional Analysis of Aerosol Effects on Clouds. Presented at IAMAP'89 Symposium on the Effects of Aerosols and Clouds on Climate, Reading, UK, 31 July-12 August, 1989.

Durkee, P. A., 1989: Global and Regional Analysis of Aerosols and Clouds: Tests for Aerosol Cloud Climate Mechanisms. Presented at the 8th Annual Meeting of the American Association for Aerosol Research. Reno, Nevada, 10-13 October, 1989.

PUBLICATIONS: Durkee, P. A., T. Benedict, and C. E. Motell, 1990: "Comparison of Ship and Satellite Observations of Aerosol Characteristics Over the Central North Pacific Ocean." To be submitted to Journal of Geophysical Research.

Durkee, P. A., 1990: "Global and Regional Analysis of Aerosols and Clouds: Tests for Aerosol Cloud Climate mechanisms." To be submitted to Nature.

THESES DIRECTED: G. Eisman, "Cloud Reflectance Characteristics in the Presence of Variable Dimethylsulfide (DMS) Sources," Master's Thesis, September 1989.

T. Benedict,"Observations of Aerosol Variations over the Central North Pacific Ocean, Master's Thesis, December 1989.

SAGE III SCIENCE TEAM PARTICIPATION

Philip A. Durkee, Associate Professor of Meteorology
Sponsor: NASA

OBJECTIVE: Participation in Stratospheric Aerosol and Gas Experiment (SAGE III) Science Team meetings and preparation of the Execution Phase proposal.

SUMMARY: Initially this effort will help to continue preparation of a proposal to fly the Stratospheric Aerosol and Gas Experiment (SAGE III) on NASA's Earth Observing System platforms. If approved, the program will grow into a ten-year study using SAGE III results with other multispectral techniques for detecting aerosols.

SATELLITE DETECTION OF MARINE ATMOSPHERIC BOUNDARY LAYER (MABL) CHARACTERISTICS

Philip A. Durkee, Associate Professor of Meteorology

Sponsor Funded - ONR sponsored

OBJECTIVE: To investigate new techniques for detecting characteristics of the marine atmospheric boundary layer. The program of study was to include participation in field experiments and theoretical radiative transfer calculations to provide physical basis for the observations.

SUMMARY: This project was designed as a three-year effort that began in FY85. The major accomplishment so far has been the quantization of the effect of aerosol particles above the marine boundary layer on the various techniques for boundary layer characterization. Also, development was begun on a technique designed to estimate boundary layer thickness and relative humidity from satellite measurements of optical depth and total water vapor. The technique uses data from only one satellite sensor but at various wavelengths. The technique is computationally efficient and will provide estimates over wide areas of cloud-free ocean.

CONFERENCE PRESENTATIONS: Durkee, P. A., 1989: Observations of aerosol-cloud interactions in satellite-detected visible and near-infrared radiance. Presented at the Symposium on the Role of Clouds in Atmospheric Chemistry and Global Climate. American Meteorological Society, January 30 - February 2, 1989, Anaheim, CA.

PUBLICATIONS: Durkee, P. A., and G. M. Mineart, 1989: Multispectral Satellite Analysis of Marine Stratocumulus Cloud Microphysics," J. Geophys. Res. *In Preparation.*

Durkee, P. A., C. E. Motell and F. M. Tettelbach, 1989: Aerosol-Cloud Interactions in the Northeast Pacific. J. Geophys. Res., Submitted.

Durkee, P. A. and S. Smolinski, 1989: Marine Boundary Layer Depth and Relative Humidity Estimation Using Multispectral Satellite Measurements," International Journal of Remote Sensing, Submitted.

THESIS DIRECTED: Lutz, John, "A Summary of Ship Track Effects on Clouds over the Eastern North Pacific Ocean," M.S., December 1989.

ELECTRONIC WEAPON SYSTEM SATELLITE SUPPORT

Philip A. Durkee, Associate Professor of Meteorology
Sponsor: NPS Direct Funded - NEPRF sponsored

OBJECTIVE: To develop a method to estimate visibility from satellite measurements of upwelling radiance. Also to evaluate the Defense Meteorological Satellite Program Operational Linescan System (DMSP OLS) and the NOAA Advanced Very High Resolution Radiometer (AVHRR) for their ability to provide input to the visibility estimation scheme.

SUMMARY: The DMSP and AVHRR sensors were evaluated for their potential for visibility estimations. The DMSP system was found to have severe limitations due to a low signal to noise ratio and to ambiguities in the upwelling radiance from the ocean surface. The AVHRR system has considerably higher signal to noise and the spectral response limits the ocean surface contribution to upwelling radiance. The AVHRR system also is able to measure radiance at multiple wavelengths which provides indications of the vertical distribution of aerosol particles. Four radiative transfer approximations were tested for their suitability in a visibility estimation scheme. Fortunately the simplest and most easily inverted approach provides accuracy within our current ability to measure aerosol optical depth from satellites. Therefore, the first version of a visibility estimation technique will be simple and easy to evaluate. The project is continuing and is expected to begin producing visibility climatologies of various ocean basins.

CONFERENCE PRESENTATIONS: Durkee, P. A., 1989: Global Estimates of Aerosol Characteristics. Presented at IAMAP'89 Symposium on Remote Sensing of Atmospheric Constituents, Reading, UK, 31 July-12 August, 1989.

PUBLICATIONS: Durkee, P. A., and M. Garcia de Quevedo, 1989: "Estimation of Infrared Extinction by Aerosols from Multispectral Satellite-Detected Radiance," Applied Optics, Submitted.

Durkee, P. A., and D. E. Burks, 1989: "Meteorological Range Estimation From Satellite-Detected Radiance," NEPRF Technical Report, In Preparation.

Durkee, P. A., E. M. Frost and R. A. Shema, 1989: "Global Scale Aerosol Particle Characteristics from Satellite-Detected Radiance," J. Geophys. Res., Submitted.

Durkee, P. A., P. J. De Vries, and L. F. Radke, 1990: "Analysis of Forest Fire Smoke from Satellite Detected Upwelling Radiance," Journal of Geophysical Research, In Preparation.

SATELLITE APPLICATIONS FOR TESS

Philip A. Durkee, Associate Professor of Meteorology
Carlyle H. Wash, Associate Professor of Meteorology
Sponsor: Naval Environmental Prediction Research Facility

OBJECTIVE: To provide NEPRF with satellite applications for the TESS 3.0 system. To prepare applications which best fit within the constraints of available data sources, available computer resources and fleet operational importance.

SUMMARY: A cloud and precipitation classification program, designed for geostationary satellite data, was applied to various cases of polar orbiting satellite data. To improve polar orbiter applications, a navigation routine was developed which will provide accurate location of the image data. Also, study was begun on the application of AVHRR multichannel data to the cloud classification algorithms. Variations in marine status cloud systems was emphasized in this study.

PUBLICATIONS: O'Sullivan, F., C.H. Wash and C. Motell, 1990: "Rain Estimation for Infrared and Visible GOES Satellite Data," Journal of Applied Meteorology, Submitted.

Allen, R. C., P. A. Durkee, C. H. Wash, 1989: "Snow and Cloud Discrimination Using Multispectral Satellite Measurements." Accepted for publication in J. Climate and Appl. Meteor.

ANALYSIS OF DATA FROM LASBEX

K.L. Davidson, Professor of Meteorology
W.J. Shaw - Associate Professor of Meteorology
P.A. Durkee, Associate Professor of Meteorology
Sponsor: NEPRF Technical Sponsor

OBJECTIVE: To investigate the general circulation of the sea breeze, the microstructure of the sea breeze front, and the relation of the aerosol distribution to this circulation using data from the Land/Sea Breeze Experiment (LASBEX).

SUMMARY: Measurement systems employed in LASBEX have revealed fascinating details of the structure of the sea/land breeze system and its evolution. Mapping of the diurnal evolution of the system using doppler sodar has revealed unexpected features such as a strong southerly jet that appeared intermittently approximately three hours priors to the passage of the sea breeze front. It has also been possible to calculate the convergence in the front from the sodar's vertical velocity, the first time that such a direct measurement has been achieved. The propagation vector for the sea breeze front has been determined from surface data and has shown a strong correlation to estimates of surface heat flux prior to the onset of the front.

PUBLICATIONS: J. M. Intrieri, C. G. Little, W. J. Shaw, P. A. Durkee, R. M. Banta and R. M. Hardesty, "The Land/Sea Breeze Experiment (LASBEX)," Bull. Amer. Meteor. Soc.

W. J. Shaw and R. J. Lind, "Sounding and Surface Meteorological Data from the Land/Sea Breeze Experiment (LASBEX)." Tech. Rpt. NPS63-90-001.

CONFERENCE PRESENTATION: W. J. Shaw, "Remote Sensing Observations of the Land/Sea Breeze Circulation in Central California." IAMAP 89 Assembly, Reading, U.K., August, 1989.

OCEAN RESPONSE TO STRONG ATMOSPHERIC FORCING

R. L. Elsberry, Professor of Meteorology
L. K. Shay, Adjunct Professor of Meteorology
Sponsor: Office of Naval Research

OBJECTIVES: The long-term objective of this research effort is to understand key physical processes in the ocean's thermal and momentum response on near- inertial time scales to strong atmospheric forcing events such as hurricanes. This study seeks to understand the relative roles of advective and mixing processes in the thermal response and the downward propagation of energy from a surface- intensified mixed layer. The current research task addresses the ocean current response to strong atmospheric forcing within the context of near- inertial wave dynamics that is linked to vertical current shear and mixing events in the upper ocean.

SUMMARY: Observational, analytical and numerical modeling approaches are used to isolate dominant forcing mechanisms or processes. During the summer of 1989, the mesoscale current and temperature structure was mapped in the Subarctic Frontal Regime in the Northeast Pacific Ocean by deploying 75 Airborne eXpendable Current Profiler's (AXCP's) on three flights from the Naval Research Laboratory (NRL) WP-3D aircraft. The AXCP's were deployed along GEOSAT tracks in a Lagrangian frame of reference following a satellite-tracked drifter that was engulfed in a feature on the southern side of the front. An investigation of the barotropic current response to hurricane Frederic has been completed using both linear and primitive equation models with a free surface. In the wake of the hurricane, the free surface is depressed a maximum of 20 cm from the undisturbed height and induces a barotropic, near-inertial oscillation with maximum amplitude of 10 cm/s (Shay, et al., 1989). At 90 km, the simulated barotropic amplitudes agree well with the observed depth-averaged current amplitudes of 10-12 cm/s from hurricane Frederic. In collaboration with Dr. Peter Black (NOAA-Hurricane Research Division), a joint NOAA/NAVY Air-Sea Interaction experiment was conducted from the NOAA WP-3D's research aircraft in hurricane Gilbert during the summer of 1988. The sea-surface temperatures (SST) decreased by 3-5 degrees C during and subsequent to the passage of Gilbert. The grid of observed SST's from the AXCP's deployed in the wake of Gilbert were within + 0.2 degrees C of those derived from satellite AVHRR SST data after a bias of 0.5 degrees C was removed from the AVHRR data (Black et al., 1989).

PUBLICATIONS: L. K. Shay, R. L. Elsberry and P. G. Black: "Vertical Structure of the Ocean Current Response to a Hurricane." J. Phys. Oceanogr., 19, 649-669, 1989.

L. K. Shay, S. W. Chang and R. L. Elsberry: "Free-surface Effects on the Near-inertial Currents Response to Hurricanes." J. Phys. Oceanogr., (in revision), 1990.

CONFERENCE PRESENTATIONS: P. G. Black, L. K. Shay and R. L. Elsberry: "Ocean Response to Hurricane Gilbert." Preprints, 19th Conference on Hurricanes and Tropical Meteorology, American Meteorological Society, 226-227, San Diego, May 1989.

L. K. Shay, R. L. Elsberry and P. G. Black: "Overview of the Ocean Response to Tropical Cyclones." Proceedings, ONR Workshop on Coupled Mesoscale Air/ Sea Interactions, Monterey, August 1989.

TROPICAL CYCLONE MOTION STUDIES

Russell L. Elsberry, Professor of Meteorology
Sponsor: Office of Naval Research

OBJECTIVE: To improve basic understanding of tropical cyclone motion. The primary focus is on understanding the role of tropical cyclone structure. The ultimate goal in this five-year program is the development of improved methods of forecasting the track of tropical cyclones, which pose one of the primary peace-time threats to the safety of fleet operating units.

SUMMARY: Fiorino and Elsberry (1989a, 1989b) clarified the role of outer wind structure in tropical cyclone motion. The focus in these papers is on the formation and evolution of large-scale, asymmetric circulations. The flow between the gyres is correlated well with the propagation vector, which is defined as the departure of the tropical cyclone motion from the advective or steering flow. A forthcoming note by Carr and Elsberry (1990) demonstrates that the sense of the propagation vector from the theoretical models is in general agreement with the published composite data studies. Evans et al. (1990) demonstrate with a high- resolution model the effects on tropical cyclone motion of the environmental vorticity gradients in the subtropical ridge. For the idealized case studied, the propagation vector was linearly related to the environmental vorticity gradient. Boerlage (1989) calculated the Isentropic Potential Vorticity (IPV) fields from a high-resolution, numerical model during a recurvature sequence. Although the initial IPV distribution near the tropical cyclone was unrepresentative, the IPV advection after 24 h appeared to indicate clearly the path of the tropical cyclone as it interacted with midlatitude circulations. Workshops in support of the ONR Tropical Cyclone Motion initiative were held in San Diego, Monterey and Manila (Elsberry 1989a, b, c). An article describing the 1990 field experiment will appear (Elsberry 1990).

PUBLICATIONS:R. L. Elsberry: "ONR Tropical Cyclone Motion Research Initiative: Field Experiment Planning Workshop." Technical Report NPS 63-89-002, Naval Postgraduate School, 79 pp., July 1989.

R. L. Elsberry: "ONR Tropical Cyclone Motion Research Initiative: Data Assimilation Considerations for Field Experiment Analysis." Technical Report NPS 63-89-006, Naval Postgraduate School, 64 pp., September 1989.

R. L. Elsberry: "ONR Tropical Cyclone Research Initiative: Technical Report NPS 63-90-002, Naval Postgraduate School, 63 pp., December 1989.

M. Fiorino, and R. L. Elsberry: "Contributions to Tropical Cyclone Motion by Small, Medium and Large Scales in the Initial Vortex." Mon. Wea. Rev., 117, 721-727, 1989.

M. Fiorino, and R. L. Elsberry: "Some Aspects of Vortex Structure Related to Tropical Cyclone Motion." J. Atmos. Sci., 46, 975-990, 1989.

R. L. Elsberry: "International Experiments to Study Tropical Cyclones in the Western North Pacific." Bulletin Amer. Meteor. Soc., (accepted), 1990.

CONFERENCE PRESENTATIONS: R. F. Abbey, Jr., and R. L. Elsberry, "Progress and Plans for the Office of Naval Research Tropical Cyclone Motion Initiative." Extended abstracts, 18th Technical Conference on Hurricanes and Tropical Meteorology, American Meteorological Society, 58-60, San Diego.

THESES DIRECTED: A. P. Boerlage, "A Description of Tropical Cyclone Recurvature in Terms of Isentropic Potential Vorticity." M.S., June 1989.

L. E. Carr III, "Vortex Adjustment and Motion in Response to Asymmetric Forcing with Application to Tropical Cyclones." Doctoral Dissertation, September 1989.

TROPICAL CYCLONE PREDICTION

R. L. Elsberry, Professor of Meteorology
Sponsor: Naval Environmental Prediction Research Facility

OBJECTIVE: The long-term objective of this continuing project is to assist the Joint Typhoon Warning Center in Guam to improve tropical cyclone forecasts.

SUMMARY: A review of the studies of the impact of the loss of aircraft reconnaissance and the reliance on satellite- derived tropical cyclone positions was completed (Elsberry 1989). The primary impact of poor initial positions on dynamical model and operational track forecasts is in the 0-24 h forecasts. However, an inaccurate warning position when the storm is at a "saddle-point" in the circulation can lead to isolated large track forecast errors. The time consistency of three tropical cyclone track prediction errors relative to best track positions (Elsberry and Dobos 1989a, 1990). The One-way influence Tropical Cyclone Model provides the most consistent forecasts in time. A 24-h forecast verification within the central one-third of the track forecasts generally provides no information about the likely correctness of the subsequent forecast. The aids have more time consistency when the error in the previous forecast is to the right of the track. A lagged-averaged forecast technique has been applied to tropical cyclone track forecasts (Bacon 1989; Bacon et al. 1989). Climatology and Persistence (CLIPER) forecasts from warning times lagging the initial times are combined at their common 24-h verifying time. When the CLIPER forecasts at 36, 48, 60 and 72 h are modified with information such as observed positions since the time those forecasts were initiated, these modified forecasts provide additional guidance as to the likely 24-h positions. Although the lagged-average technique improves the accuracy and consistency of the track predictions by about 7% in the dependent sample, only about half of this improvement is sustained in the independent sample (Elsberry and Dobos 1989b, 1990). A prototype expert system to forecast tropical cyclone wind conditions at Cubi Point, Philippines has been developed (Dobos et al. 1989). Different strategies of relating the maximum winds and gusts to the storm intensity lead to variations in the "capture rate" of gale winds, the false alarm rate and the percent correct. Thus, the prototype indicates the potential of expert systems for local wind event predictions. Consequently, a second prototype expert system to forecast levante and mistral winds in the western Mediterranean was developed (Jones 1989).

PUBLICATIONS: R. L. Elsberry and P. H. Dobos: "Time Consistency of Track Prediction Aids for Western North Pacific Tropical Cyclones," Mon. Wea. Rev., 118, February 1990.

R. L. Elsberry, 1989: "Reflections on the Impact of Fix Type and accuracy on Tropical Cyclone Track Forecasts," Technical Report, Naval Postgraduate School, 43 pp., July 1989.

CONFERENCE PRESENTATIONS: A. B. Bacon, R. L. Elsberry and P. H Dobos, "Application of the Lagged- averaged Technique to Tropical Cyclone Track Predictions," 18th Conference on Hurricanes and Tropical Meteorology, American Meteorological Society, San Diego, 34-37, May 1989.

P. H. Dobos, B. M. Hagaman and R. L. Elsberry, "A Prototype Expert System for Setting Tropical Cyclone Wind Conditions at Cubi Point, Philippines." Preprints, 18th Conference on Hurricanes and Tropical Meteorology, American Meteorological Society, San Diego, 13-16, May 1989.

R. L. Elsberry and P. H. Dobos, "Time Consistency of Track Prediction Aids for Western North Pacific Tropical Cyclones." Preprints, 18th Conference on Hurricanes and Tropical Meteorology, American Meteorological Society, San Diego, 13-16, May 1989.

R. L. Elsberry and P. H. Dobos, "Recent Tropical Cyclone Research at the Naval Postgraduate School." Proceedings Environmental Group U.S. Pacific Command Tropical Cyclone Conference, Hawaii, February 1989.

R. L. Elsberry and P. H. Dobos, "Recent Tropical Cyclone Research at the Naval Postgraduate School." Proceedings Environmental Group U.S. Pacific Command Tropical Cyclone Conference, Guam, February 1989.

THESES DIRECTED: A. B. Bacon, CPT USAF, "Application of the Lagged- averaged Technique to Tropical Cyclone Track Predictions." M.S., June 1989.

M. Jones, "A Prototype Expert System to Forecast Gale Conditions in the Western Mediterranean." M.S., June 1989.

OBSERVATIONAL-NUMERICAL STUDY OF MARITIME EXTRATROPICAL CYCLONES USING FGGE DATA

R.L. Elsberry, Professor of Meteorology
C. H. Wash, Associate Professor of Meteorology
Sponsor: National Aeronautics and Space Administration

OBJECTIVE: To better understand the development maturation and decay of maritime extratropical cyclones using a combined observational and numerical modeling approach.

SUMMARY: Diagnostic studies of all rapid and normal developing cyclones have been extended to cover entire winter FGGE SOP. Wright thesis results have been prepared for publication.

PUBLICATION: C. H. Wash, R. Hale, P. Dobos, E. Wright, "Diaaagnostic Study of Explosive Cyclogenesis during FGGE," Mon. Wea. Rev., Submitted.

THESIS DIRECTED: E. Wright, "Study of Explosive and Non-explosive Cyclogenesis," Master's Thesis, December 1988.

EXTRATROPICAL RAPID MARITIME CYCLOGENESIS STUDIES

R.L. Elsberry, Professor of Meteorology
Carlyle H. Wash, Associate Professor of Meteorology
Wendell A. Nuss, Assistant Professor of Meteorology
Sponsor: Office of Naval Research

OBJECTIVE: The long-range goal of this research is to understand the physical processes responsible for rapid cyclogenesis at sea. The following unifying hypothesis to explain rapid maritime cyclogenesis has been refined and tested using Genesis of Atlantic Lows Experiment (GALE) data and is being applied to the diagnosis of data from the Experiment on Rapidly Intensifying Cyclones over the Atlantic (ERICA): Rapid development of marine cyclones represents a favorable superposition of upper- and lower-level forcing mechanisms under low static stability conditions. Modification of the development rate is accomplished by a favorable interaction with the distribution of sea-surface temperature as well as by substantial release of latent heat due to condensation.

SUMMARY: Analysis of GALE IOP-9 and IOP-2 was completed using the multivariate optimal interpolation analysis within the Navy Operational Regional Atmospheric Prediction System (NORAPS) and various model simulations. Results have shown that vertically consistent fields are crucial for correct predictions of these cyclones. Additional offshore data taken during GALE were invaluable in documenting and analyzing the IOP-9 cyclone. Analysis of the GALE IOP-2 cyclone, which occurred primarily over land, has revealed that the NORAPS tendency to predict cold surges that are too quick and too weak was a major source of prediction error for this case. The field phase of ERICA was completed during the beginning of 1989. Data were collected for a total of eight intensive observation periods and preliminary analysis of this data was begun. Preliminary synoptic descriptions of the two most intense cyclones during ERICA, IOP's 2 and 4 have been completed by Chalfant (1989) and Kreyenhagen (1989). Analysis techniques have been developed and data sets have been installed on the IDEA lab for further testing of the basic hypothesis for rapid cyclogenesis.

PUBLICATIONS: Wash, C.H., S.M. Heikkinen, C.-S. Liou and W.A. Nuss, 1990: IOP-9 Cyclogenesis Diagnostic and Numerical Forecast Studies," Mon. Wea. Rev., pp. 375-391, 1989.

Liou, C.S., S.M. Heikkinen, C.H. Wash and R.L. Elsberry, 1990: Numerical Studies of GALE IOP-2 Cyclogenesis," Mon. Wea. Rev., pp.218-233, 1989.

Nuss, W.A. and S.I. Kamikawa, 1990: Dynamics and Low-Level Processes in Two Asian Cyclones," Mon. Wea. Rev., In press.

THESES DIRECTED: D.K. Crittenden, LCDR, "Thermodynamic and dynamic processes in the updraft region of GALE IOP 9. Master's Thesis, March 1989.

A. Chalfant, CAPT, "Dynamics of the ERICA IOP-2 Cyclone." Master's Thesis, June 1989.

M. Kreyenhagen, LCDR, "Comparison of the Dynamics of a Land vs. Oceanic Explosive Cyclone." Master's Thesis, December 1989.

LARGE-EDDY SIMULATION OF ARCTIC-LEAD INFLUENCES ON THE ATMOSPHERIC BOUNDARY-LAYER

John W. Glendening, Adjunct Professor of Meteorology
Sponsor: NOARL (Navy reimbursable)

OBJECTIVE: Investigate the microscale three dimensional turbulent flow dynamics within the atmospheric boundary- layer in the vicinity of an arctic lead and over the surrounding ice.

SUMMARY: This work supports NOARL's Arctic Leads initiative, which involves extensive observational studies in the vicinity of breaks in the polar ice field which expose the underlying ocean. A large-eddy simulation (LES), which directly predicts turbulent eddies rather than parameterizing their effects, is employed to predict the turbulent observations to be expected in such a program and to yield analyses which the observed data is unable to provide. This case is of scientific importance because the surface forcing is nonhomogenous and it also contributes to the study of turbulence decay dynamics. Since no previous LES investigation has considered non-homogeneous forcing on such a small scale, the first phase involved testing whether such an approach could be successful. Several model modifications were required before promising results were obtained. Because such models are extremely computer intensive, requiring days of computer time, in the second phase several coarse grid preliminary trials were run to ascertain the most suitable parameters within the bounds of constraints imposed by the physical problem and by the modeling technique. The third phase, a full scale simulation, is presently underway.

EDDY GENERATION MECHANISMS IN EASTERN BOUNDARY CURRENT REGIONS

Robert L. Haney, Professor of Meteorology
Sponsor: Office of Naval Research

OBJECTIVE: Investigate the role of winds and variable bottom topography in influencing jets and eddies in the California Current.

SUMMARY: Ocean data from the 1988 Coastal Transition Zone (CTZ) program have been used to form a composite description of the coastal jet off California, and the behavior of this jet over variable topography, with and without wind forcing will be studied with a numerical model. The CTZ field data will also be used to perform data assimilation and model hindcast studies with the numerical model.

PUBLICATIONS: M. L. Batteen, R. L. Haney, T. A. Tielking, and P. G. Renaud, "A Numerical Study of Wind Forcing of Eddies and Jets in the California Current System," J. Mar. Res., 47, 493-523, (March 1989).

R. L. Haney, "On the Pressure Gradient Force over Steep Topography in Sigma Coordinate Ocean Models," J. Phys. Ocgr., Submitted.

MESOSCALE MODELING OF THE ATMOSPHERIC BOUNDARY LAYER

Teddy R. Holt, Assistant Professor of Meteorology
Sponsor: NPS Research Council

OBJECTIVE: Examine boundary layer structure and circulation using an advanced boundary layer parameterization in a three-dimensional mesoscale numerical model.

SUMMARY: Relatively complex parameterizations of the planetary boundary layer (PBL) such as the turbulent kinetic energy (TKE) parameterization are able to simulate boundary layer features such as the low level jet. The importance of the PBL and PBL parameterizations in a three-dimensional numerical model is examined. Considered are the effects of the jet on turbulent exchanges in the PBL due to strong shear instability. Subsequently, the combined effects of shear instability due to the low level jet and the associated increased turbulent exchange on coastal cyclogenesis is examined using 1986 Genesis of Atlantic Lows Experiment (Gale) data.

BOUNDARY LAYER MODELING IN EXPLOSIVE CYCLOGENESIS

W. Nuss, Professor of Meteorology
Sponsor: Office of Naval Research

OBJECTIVES: The long-range goal of this research is to understand the role of boundary layer processes in frontogenesis and cyclogenesis and to better represent these processes in numerical simulations of cyclogenesis. The objectives of this research are to describe the effect that horizontally varying boundary layer structure and processes have on frontogenesis associated with oceanic cyclogenesis and to investigate the role of the sea surface temperature distribution and initial boundary layer structure in forcing warm frontogenesis in numerical simulations of oceanic cyclones.

SUMMARY: Model simulations of an idealized cyclone have been used to investigate the effect of various surface flux distributions on surface frontogenesis. Diagnostics of the frontogenesis using the Sawyer-Eliassen equation for the secondary circulation around fronts have been done and indicate that boundary layer frictional convergence generated by a change in boundary layer stratification across a developing warm front was the dominant mechanism to force frontogenesis during the first 18 hours of the model simulation. Surface flux differences across the front were found to be the primary factor in creating the frictional differences across the front. Model simulations of Intensive Observation Period (IOP) 9 from the Genesis of Atlantic Lows Experiment (GALE) were run under various surface boundary conditions in order to diagnose similar effects in an actual cyclone. Analysis has not been completed at this time.

CONFERENCE PRESENTATIONS: W.A. Nuss, "Warm Frontal Intensity in the Oceanic Boundary Layer and its Impact on Cyclogenesis," 12th Conference on Weather Analysis and Forecasting, Monterey, CA Oct. 1989.

THESIS DIRECTED: Susan A. Davies, LCDR, "A Day in the Life of a Warm Front. Master's Thesis, December 1989.

AIRCRAFT MEASUREMENTS IN THE FRONTAL AIR-SEA INTERACTION EXPERIMENT

W. J. Shaw - Associate Professor of Meteorology,
Sponsor: National Science Foundation

OBJECTIVE: Use aircraft measurements to investigate the structure of the atmospheric boundary layer in the vicinity of an open ocean front.

SUMMARY: Several means of interaction between the atmospheric and the ocean in the vicinity of an open ocean front have been postulated. These include roughness changes which could induce convergence or divergence under conditions of wind flow perpendicular to the front and stress curls which could induce vertical velocity through the vorticity balance. Data collected in the Sargasso Sea using the Electra research aircraft operated by the National Center for Atmospheric Research (NCAR) have been analyzed to delineate the structure of the atmospheric boundary layer across such an ocean front. The aircraft has been used to map the sea surface temperature, the mean structure, and fluxes due to turbulence in a 1000 km2 box centered on the front. Mesoscale variations in the surface fluxes and in the drag coefficient determined from the aircraft data indicate that the front is a dominant organizer of the atmosphere only under one specific flow regime. The remainder of the time, the interaction between the air and the sea is a combination of surface forcing and atmospheric mesoscale organization.

PUBLICATIONS: F.-K. Li, W. G. Large, W. J. Shaw, E. Walsh, and K. L. Davidson, "Ocean Radar Backscatter Relationship with Near-Surface Winds: A Case Study During FASINEX," J. Phys. Oceanog., 19, 342-353.

S. A. Stage, W. J. Shaw, "The Response of the Atmosphere to Oceanic Fronts," J. Geophys. Res., In Progress.

C. A. Friehe, W. J. Shaw, D. P. Rogers, K. L. Davidson, W. Large, S. Stage, and G. Crescenti, "Variation of Surface Fluxes in the Vicinity of an Open Ocean Front," J. Geophys. Res., Submitted.

W. J. Shaw, R. J. Lind, and K. L. Davidson, "Mesoscale Variability of the Drag Coefficient," J. Geophys. Res., To be Submitted.

R. J. Lind and W. J. Shaw, "Sea Surface Temperature Fields Derived From Aircraft and Ship Observations During FASINEX 1986," Tech. Rpt NPS-63-89-001.

CONFERENCE PRESENTATIONS: W. J. Shaw, "NCAR Electra Measurements in FASINEX." Int. Wkshp. on the Airborne Measurement of Wind, Turbulence, and Position. Oberpfaffenhofen, FRG. July, 1989.

AUTOMATED EARTH LOCATION OF SATELLITE DATA

C.H. Wash, Associate Professor of Meteorology,
P.A. Durkee, Associate Professor of Meteorology,
Sponsor: Defense Mapping Agency

OBJECTIVE: To apply Defense Mapping Agency World Vector Shoreline digital database and necessary earth location technology to digital environmental satellite imagery for use in environmental command and control.

SUMMARY: Shoreline database received and read. Preliminary earth location studies completed.

THEORY OF TROPICAL CYCLONE MOTION

R. T. Williams, Professor of Meteorology
M. S. Peng, Adjunct Research Professor of Meteorology
Sponsor: Office of Naval Research

OBJECTIVE: To understand the physical processes which control the motion of tropical cyclones. This is a continuing project.

SUMMARY: An analytic model was developed in a frame of reference moving with the vortex, and the vorticity equation was linearized. We solved numerically both the steady state and the time-dependent forms of the equation. The solutions were unrealistic in the inner region. This behavior was found to be related to barotropic instability of the vortex. When this instability was controlled, the proper structure was obtained when the vortex speed was correct. In addition, the steady state equation was solved analytically for certain analytic profiles. These solutions showed the beta-gyres with the proper orientation and strength. The full numerical model was also integrated with two basic environmental wind fields: (1) linear, (2) parabolic; both of these wind fields lead to modifications in the beta drift process. A further study examined the linear stability of disturbances in a 1/r vortex. It was found that smooth initial disturbances were strongly damped by the continuous spectrum modes. The results strongly suggest that tropical cyclones and typhoons are made nearly circular by this process.

PUBLICATIONS: L.E. Carr,III and R.T. Williams, "Barotropic Vortex Stability to Perturbations From Axisymmetry." Journal of the Atmospheric Sciences, 46, 3177-3191, 15 October 1989.

M.S. Peng and R.T. Williams, "Dynamics of Vortex Asymmetrics and their Influence on Vortex Motion on a Beta-Plane." Journal of the Atmospheric Sciences, Accepted for publication.

J.C.-L. Chan and R.T. Williams, "Analytical and Numerical Studies of Tropical Cyclone Motion, Part II: East-West Mean flow," In preparation.

THESIS DIRECTED: L.E. Carr, III, "Barotropic Vortex Adjustment to Asymmetric Forcing with Application to Tropical Cyclone Motion," Ph.D., September 1989.

CONFERENCE PRESENTATIONS: L.E. Carr and R.T. Williams, "Barotropic Vortex Stability to Perturbations From Axisymmetry." 18th Conference on Hurricane and Tropical Meteorology, San Diego, 16-19 May 1989.

M.S. Peng and R.T. Williams, "Dynamics of Vortex Asymmetries and their Influence on Vortex Motion on a Beta-Plane." 18th Conference on Hurricane and Tropical Meteorology, San Diego, 16-19 May 1989.

M.S. Peng and R.T. Williams, "Instability of the Tropical Cyclone Radial Profile and its Association with Cyclone Movement." 7th Conference on Atmosphere and Oceanic Waves and Stability, San Francisco, 10-14 April, 1989.

NUMERICAL MODELING OF UNIQUE ATMOSPHERIC PHEMNOMENA

R.T. Williams, Professor of Meteorology
M.S. Peng, Adjunct Professor of Meteorology
Sponsor: Office of Naval Research

OBJECTIVE: Develop and test better numerical techniques for use in Navy weather forecasting models. This is a continuing project.

SUMMARY: The effect of topography on the evolution of a disturbance in a baroclinically unstable mean flow was studied using a three-dimensional model. It was found that the lee cyclogenesis was caused primarily by the superposition of a growing baroclinic wave upon steady, orographically forced wave of the same scale. Flow over steep mountains was calculated with two and three dimensional numerical models. For sufficiently steep mountains hydraulic jumps were found on the lee side of the mountain. Two-dimensional studies on fronts moving over topography were carried out. Frontal solutions with no forcing were compared with the scalar advection theory of Blumen and Gross. A study of frontogenesis with growing non-model disturbances was begun.

PUBLICATIONS: J L. Hayes, R.T. Williams and M.A. Rennick, "Lee cyclogenesis. Part II: Numerical Studies," under revision for Journal of the Atmospheric Sciences.

R.T. Williams, M.S. Peng and D.A. Zankofsky, "Effects of Topography on Fronts," In progress.

CONFERENCE PRESENTATION: R.T. Williams and M.S. Peng: "Influence of Topography on Fronts," IAMAP Fifth Scientific Assembly, University of Reading, United Kingdom, 31 July-12 August, 1989.

DEVELOPMENT OF A FINITE ELEMENT PREDICTION MODEL

R.T. Williams, Professor of Meteorology;
A.L. Schoenstadt, Professor of Mathematics
B. Neta, Associate Professor of Mathematics
Sponsor: Office of Naval Research

OBJECTIVE: To develop and test a finite element atmospheric prediction model. This is a continuing project.

SUMMARY: The research on vertical finite element schemes used the linearized baroclinic vorticity-divergence equations for a single horizontal spectral mode. Three finite difference schemes were compared with the three finite element schemes, which had nodal points corresponding to grid points in the finite difference schemes. These numerical schemes were applied to a baroclinic instability situation with linear and hyperbolic wind profiles. A semi-Lagrangian scheme was developed for Burgers equation. Near the time of discontinuity formation the scheme was much better than finite difference and tau spectral formulations. Further studies of the semi-Lagrangian method were carried out with the one-dimensional shallow water equation with topography. A semi-implicit version gave much better results than the explicit version. The linearized shallow water equations in a channel were solved with a linear cross-channel depth variation. Finite difference solutions were compared with analytic solutions that were written in terms of confluent hyperbolic functions.

PUBLICATIONS: B. Neta and R.T. Williams, "Rossby Wave Frequencies and Group Volocities for Finite Element and Finite Difference Approximations to the Vorticity-Divergence and Primitive Forms of the Shallow Water Equations," Mon. Wea. Rev., 117, 1439-1457, July 1989.

H.-C. Kuo and R.T. Williams, "Semi-Lagrangian Solutions to the Inviscid Burgers Equation," Mon. Wea. Rev., Accepted for publication.

A.N. Staniforth, R.T. Williams and B. Neta, "Influences of Linear Depth Variations on Barotropic Kelvin and Poincare' Waves," In preparation.

THESIS DIRECTED: B. Monk, " Semi-Lagrangian, Semi-Implicit Solutions of the Shallow Water Equations in One Dimension," M.S., June 1989.

CONFERENCE PRESENTATIONS: B. Neta and R.T. Williams, "Analysis of Finite Element and Finite Difference Methods for the Solution of the Vorticity-Divergence Form of the Shallow Water Equation," International Symposium on Computational Fluid Dynamic, Nagaya, Japan, 28-31 August, 1989.

B. Neta and R.T. Williams, "A Comparative Study of Finite Elements and Finite Difference for Weather Predictions," Fifth International Symposium on Numerical Methods in Engineering, Lausanne, Switzerland, 11-15 September 1989.

R.T. Williams, A.N. Staniforth and B. Neta, "Solutions of a Generalized Sturm-Lioville Problem," Computation of Ordinary Differential Equations, London, England, 3-7 July, 1989.

AIR FLOW OVER LARGE SCALE TOPOGRAPHY

R.T. Williams, Professor of Meteorology
M.A. Rennick, Adjunct Professor of Meteorology
M.S. Peng, Adjunct Professor of Meteorology
Sponsor: National Science Foundation

OBJECTIVE: To utilize observational results from ALPEX with theoretical and numerical studies to investigate the interaction between air flow and large scale topography. This is a continuing project.

SUMMARY: The formation of cyclones in the lee of a mountain range was studied with numerical models. The problem of flow over and around a long mountain range was investigated with two and three dimensional finite difference models. The effect of topography on fronts was studied with a two-dimensional numerical model. Also the frontal solutions were compared with an advected scalar when there was no forcing.

PUBLICATIONS: J.L. Hayes, R.T. Williams and M.A. Rennick, "Lee cyclogenesis. Part II: Numerical Studies," under revision for Journal of the Atmospheric Sciences.

R.T. Williams, M.S. Peng and D.A. Zankofsky, "Effects of Topography on Fronts," 1989 In preparation.

M.A. Rennick and R.T. Williams, "Final Technical Report of Grant ATM8610354 Air Flow over Large Scale Topography," Naval Postgraduate School Report NPS-63-89-003, June 1989, pp. 106.

CONFERENCE PRESENTATIONS: R.T. Williams and M.S. Peng, "The influence of topography on fronts," IAMAP Fifth Scientific Assembly, University of Reading, United Kingdom, 31 July-12 August, 1989.

REGIONAL SYNOPTIC FORECASTING (CENTRAL AMERICA)

F.R. Williams, Professor of Meteorology
R.J. Renard, Professor of Meteorology
Sponsor: Naval Environmental Prediction Research Facility

OBJECTIVE: To produce handbooks describing the analysis and forecasting of atmospheric and oceanic conditions important to air/sea operations over key areas of interest to the Navy.

SUMMARY: Following data gathering during 1986 to 1988, a 508 page Forecasters Handbook for Central America and Adjacent Waters (including the Caribbean Sea and easter North Pacific Ocean was published. The handbook describes the analysis and forecasting of both atmospheric and oceanic conditions important to air/sea operations over Central American and adjacent waters. Central America is defined to include Guatemala, Belize, El Salvador, Honduras, Nicaragua, Costa Rica, and Panama. Case studies using satellite imagery are presented for the rainy season, dry season, and hurricane season. Sections also are included on general climatology and coastal geophysical influences.

PUBLICATION: F.R., Williams, G.H. Jung, R.J. Renard, "Forecasters Handbook for Central America and Adjacent Waters," NEPRF Technical Report 89-08, September 1989.

REGIONAL SYNOPTIC FORECASTING (PHILIPPINES)

F.R. Williams, Adjunct Professor of Meteorology
R.J. Renard, Professor of Meteorology

OBJECTIVE: To produce handbooks describing the analysis and forecasting of atmospheric and oceanic conditions important to air/sea operations over the areas of interest to the Navy.

SUMMARY: During the last half of 1989, preliminary work has included; a gathering lists of references on the Philippine areas, auditing a tropical meteorology course which presented the status of the latest research in tropical cyclone steering forecasting, reviewing climatology and forecasting references for the Philippines and adjacent waters, as well as preparing travel plans and communicating with points of contact (POCs) at NAVOCEANCOMFAC CUBI POINT RP, DET 5, 20th WEATHER SQUADRON CLARK AB RP AND NAVOCEANCOMCEN GUAM.

DEPARTMENT OF NATIONAL SECURITY AFFAIRS

NATIONAL SECURITY AFFAIRS

The research conducted by faculty in the Department of National Security Affairs is encompassed mainly within the two broad and overlapping rubrics of regional studies and strategic planning. Several of the faculty research and publish in both areas, and a project will often include both. In the former are the following projects: Donald Abenheim's Navy direct funded research on the Defense Policies of the Federal Republic of Germany for OP-OOK; Thomas Bruneau's direct funded project on Portugal, NATO, and the United States for OP-614; Claude Buss' ongoing research on the Philippines and the U.S. Bases; Edward Laurance's direct funded project on Methodologies For Evaluating Technology Transfer and Security Assistance for NOVOTTSA; Ralph Magnus' project on Jordanian-Palestinian Relationships and Post-Jihad Afghanistan for the Office of the Secretary of Defense (OSD); Edward Olsen's direct funded project for OP-60 on Implications for the U.S Navy of Changes in the Pacific Region; Russel Stolfi's direct funded project on the Implications of German Command Style for the U.S. Marine Corps; Scott Tollefson's research on Brazilian Missile Technology; and Mikhail Tsypkin's direct funded project on Restructuring the Soviet Navy and his OSD sponsored project on Glasnost and Secrecy in the Soviet Military.

Within strategic planning are the following projects: Jan Breemer's revision, with direct funding, of the bibliography on the Maritime Strategic Debate; Edward Laurance's involvement in the Chief of Staff of the Army project on Burden Sharing, International Armaments Cooperation, and U.S. Mobilization Capability; Robert Looney's direct funded project for NOIC on A Forecasting Model For World Ocean Shipping; James Tritten's Defense Nuclear Agency (DNA) sponsored projects on Nuclear Assessments, his Office of Net Assessment (OSD/NA) project on Strategic Management for the Defense Department as well as the project on Analysis of War Games, and the direct funded project for OP-603 on the Relationship of War at Sea to Warfare Ashore; and David Yost's project for OSD/NA on Structural Factors in the Long-term Competition. Professor Tritten's projects deal overwhelmingly with strategic planning, and Professor Yost's include large elements of regional studies.

The faculty in the Department of National Security Affairs has made good use of the research possibilities provided by the Navy direct funding arrangement. They also actively seek to maintain and diversify other funding sources throughout the Department of Defense.

The results of the research are disseminated in a great variety of means including the following: books, chapters in books, articles in scholarly journals, articles in more popular journals, technical reports (classified and not), reports specifically for research sponsors, conference presentations, and briefings for sponsors.

THE WEST GERMAN ARMED FORCES UNTIL THE YEAR 2000

Donald Abenheim, Assistant Professor of National Security Affairs
Sponsor: Chief of Naval Operations, Executive Panel (OP-OCK)

OBJECTIVE: An analysis of the past present and future evolution of West German defense policy, with particular attention to the character of politics and society as they affect grand strategy and maritime strategy.

SUMMARY: The Federal Republic of Germany faces a complex set of issues in the making of security policy that are quite unlike the American military experience. The Federal Republic must operate within a variety of supra-national entities to make its security requirements known and into a thing of the national interest. This problem derives from the experience of the past as well as from the important changes in the international system visible in the past year. As regards the US armed forces, the armed forces of the FRG are shrinking in size. This decline is especially true of the navy of the FRG.

PUBLICATIONS: The Revival of German Military Thought, Hoover Institution, forthcoming, April 1990 Manning the German Military, Yale University, forthcoming.

CONFERENCE PRESENTATIONS: Donald Abenheim, The Past, Present and Future of German Defense, Heritage Foundation, 6 March 1989 (roundtable, invited); Past, Present and Future of West German Security, Consulate General of FRG, San Francisco, California, 22 March 1989.

THE U.S. NAVY, NATO, AND PORTUGAL

Thomas C. Bruneau, Professor of National Security Affairs
Sponsor: OP-614

OBJECTIVES: Investigate the issues involved in the Portuguese request in 1988 to include the Azores within the IBERLANT area of operations.

SUMMARY: The United States has access rights to Lajes Field in the Azores under the terms of an executive agreement signed by the U.S. and Portugal in 1983. Lajes is important for resupplying Europe, out of area operations, and for U.S. Navy ASW activities. The Azores are under the responsibility of SACLANT in Norfolk. Since 1982 IBERLANT in Lisbon is under a Portuguese Vice Admiral. In the context of difficulties in implementation of the executive agreement, concern with the entry of Spain into NATO, and diplomatic problems, the Portuguese raised the issue of including the Azores within the IBERLANT area of responsibility. Given the level of classification for ASW activities this could raise problems for the U.S. Navy. The study evaluated the issues and suggested a strategy to deal with the potential problems.

PUBLICATIONS: Thomas C. Bruneau, "The U.S. Navy, NATO, and Portugal" An unpublished and classified report for OP-614.

Thomas C. Bruneau, "Portugal Fifteen Years after the April Revolution," Universities Field Staff International Reports, August 1989.

CONFERENCE PRESENTATIONS: Thomas Bruneau, "Portugal, the U.S. and NATO," The European Studies Program at the Hoover Institution, June 14, 1989.

Thomas Bruneau, "The Portuguese Constitution of 1976: The Process of Revision," The Camoes Center of Columbia University, November 10, 1989.

BURDEN SHARING, INTERNATIONAL ARMAMENTS COOPERATION, AND U.S. MOBILIZATION CAPABILITY

E.J. Laurance, Associate Professor of National Security Affairs
D. Whipple - Professor, Department of Administrative Sciences
Sponsor: Program Management Systems Development Agency
Office of the Chief of Staff of the Army

OBJECTIVE: During the winter and spring of 1989 I contributed to the development of a research proposal for research during AY 1990. The proposal was approved and I am an Associate Investigator. During the summer quarter 1990 I will be conducting empirical analysis of the development of an integrated West European Defense market in conjunction with the Single Market 1992 Act of the European Economic Community. I have circulated my research and other pertinent research findings to the other associate investigators, and will participate in a conference to be held at NPS during the summer quarter.

DEVELOPMENT AND UTILIZATION OF ANALYTICAL TOOLS IN SUPPORT OF POLICY ANALYSIS FOR THE NAVY OFFICE OF TECHNOLOGY TRANSFER AND SECURITY ASSISTANCE (NAVOTTSA)

E.J. Laurance, Associate Professor of National Security Affairs
Sponsor: NAVOTTSA

OBJECTIVE: The objective of this research project was to apply analytical tools in the support of NAVOTTSA's mission. Various types of analytical software are to be tested as to their applicability to issues of concern of NAVOTTSA. In addition, strategic assessments will be made of the international environment for foreign military sales, as well as the environment in several key countries allied with the United States.

SUMMARY: A major assessment of the international environment was made, with emphasis on the naval equipment market, the role of Japan as an arms supplier, and the potential for a West European defense market to emerge as a result of the Single Market 1992 Act of the European Economic Community.

PUBLICATIONS: E.J. Laurance, "Worldwide Armament Sales: Supply, Demand and Forecast for the 1990s," Technical Report. December 1989.

E.J. Laurance, "DON Strategic Plan for International Cooperation With Pakistan (U)," 25 January 1989. Classified working paper on the Pakistani Navy.

E.J. Laurnace, "DON Strategic Plan for International Cooperation With Turkey (U)," 25 January 1989. Classified working paper on the Turkish Navy.

THE HASHEMITE CONNECTION: CURRENT ISSUES IN JORDANIAN -PALESTINIAN RELATIONS

R.H. Magnus, Associate Professor of National Security Affairs
J.W. Amos, II - Associate Professor of National Security Affairs
Sponsor: Undersecretary of Defense for Policy

OBJECTIVE: This project seeks to define and analyze the constant factors which, over time, have promoted co-operation and conflict in the Jordanian-Palestinian relationship.

SUMMARY: During the reporting period it was necessary to update the earlier data to account for the developments in both the Palestinian and Jordanian sides related to their response to the Palestinian uprising (the intifadah). The Jordanians made a major departure in the internal political system by holding relatively free elections, which resulted in the victory of Islamic elements. The PLO continued its dialogue with the United States that began in 1988 following its recognition of the UN 242 Resolution. In general, a new period of cooperation began between the Jordanian government and the PLO began. This has been based on parallel assessments of the opportunities and dangers presented to each by the intifadah.

THESIS DIRECTED: J.M. Nazimek, LT, USN, "American and Israeli Views of the Role of the Palestine Liberation Organization in the Arab-Israeli Peace Process," M.S., September 1989.

POST - JIHAD AFGHANISTAN: IDEOLOGY, STRUCTURE AND ORIENTATIONS

R. H. Magnus, Associate Professor of National Security Affairs
Sponsor: Undersecretary of Defense for Policy

OBJECTIVE: The objective of this project is to describe and evaluate the character, orientations and policies likely to emerge from a new regime in post-Soviet withdrawal Afghanistan. The degree to which such a regime establishes sits authority and meets the needs of reconstruction, as well as its foreign policy orientations towards Pakistan, Iran, India, the USSR and the United States will have an important impact on the stability of this region and upon United States national interests.

SUMMARY: During the reporting period the situation changes as the major contingents of Soviet forces were withdrawn, in accordance with the Geneva Agreement, but the USSR continued to provide military advisers, weapons and support to maintain the communist regime in the capital and many major cities. The continuation of the war has imposed new burdens on the mujahidin resistance to maintain their unity until their final objective of the establishment of an Islamic government in Afghanistan has been achieved. Study of the data in the reporting period does not show any major changes in the fundamental orientations of various mujahidin organizations, but the continuation of the war will undoubtably pose new problems with regard to foreign policy in the region and in relation to the superpowers, as well as delay the consolidation of the power of the periphery.

CONFERENCE PRESENTATIONS: R.H. Magnus, "Current Views of the Mujahidin," Round Table on Afghanistan and Pakistan, Sixth Annual Meeting of the American Council for the Study of Islamic Societies, Villanova University, Villanova, PA (May 1989). "Political Possibilities in Post-withdrawal Afghanistan," Second CENTAF Symposium on Southwest Asia, Shaw AFB, South Carolina (March 1989).

THESIS DIRECTED: David Ray Johnson, CAPT., USAF , "Soviet Counterinsurgency." M.S., June 1989.

FUTURE OF THE ANZUS PACT AND ITS SIGNIFICANCE FOR REGIONAL SECURITY IN THE WESTERN PACIFIC

E. A. Olsen, Professor of National Security Affairs
D. Winterford, Adjunct Professor of National Security Affairs
Sponsor: CNO/Plans, Policy, & Operations

OBJECTIVE: To assess the impact of New Zealand's anti-nuclear policy on the United States within ANZUS, bilateral U.S. security relations with Australia and New Zealand, and their probable impact on the nuclear-free movements elsewhere in the Pacific and U.S. alliance cohesion in the region.

SUMMARY: The United States' policy toward the "Kiwi disease" has had unexpected consequences. While it has reinforced to the Australians and New Zealanders the United States' resistance to anti-nuclear sentiments that might disrupt other alliances, as it has ANZUS, Washington has not managed to alter the commitment of the Kiwis to pursuing their own policy goals. Moreover, the changes in ANZUS may be setting a precedent for other alliances in the region. The latter may be the key result of ANZUS-induced shifts. Asian security partners of the United States display in their defense policies several parallels with ANZUS that should be worrisome to American officials.

CONFERENCE PRESENTATION: E.A. Olsen, "Parallels between ANZUS and Northeast Asia," Presented at the annual meeting of the Section on International Strategic Studies of the International Studies Association, at Whittier College, 9 November 1989.

ROLE OF SEAPOWER IN THE PACIFIC CENTURY: IMPLICATIONS FOR THE UNITED STATES

E. A. Olsen, Professor of National Security Affairs
Sponsor: CNO/Plans, Policy, & Operations

OBJECTIVE: To analyze ways in which the growth of Pacific seapower has influenced past, present, and future U.S. security interests. The initial years work is focused on how U.S. period has contributed to a strategic environment conducive to economic prosperity, and the ways in which that prosperity is reinforcing the importance of seapower in the region.

SUMMARY: One quarter's preliminary research and interviews have been done. After two more quarters and an intersession, a mid-point report will be prepared.

THE GERMAN 7TH PANZER DIVISION IN FRANCE AND RUSSIA 1940-1941: GERMAN COMMAND STYLE ON THE STRATEGIC OFFENSIVE

R.H.S.Stolfi, Professor of National Security Affairs
Sponsor: U. S. Marine Corps

OBJECTIVE: To examine several German ultra mobile advances of 1940-1941 and suggest lessons for applications today. (Research completed April-June 1989).

SUMMARY: The Germans displayed a style of fighting in France (1940) and Russia (1941) that translated into great success on the strategic offensive. The primary investigator pieced together that style in terms of the operations the German 7th Panzer Division. Based on those operations the investigator suggested seven courses of action to improve present USMC war fighting including, for example, analysis of the reasons for the extraordinary differences in the numbers and ranks of general staff officers in similar combat formation.

THESIS DIRECTED: Robert G. Walters, CPT, USA, "Order Out of Chaos: A Case Study of the Application of Auftragstaktek by the 11th Panzer Division During the Chir River Battle 7-19 December 1942," M.S., March 1989.

BRAZILIAN MISSILE TECHNOLOGY: IMPLICATIONS FOR REGIONAL AND GLOBAL SECURITY

S.D. Tollefson, Adjunct Professor of National Security Affairs
Sponsor: Naval Postgraduate School Research Council

OBJECTIVE: The topic of my research, Brazilian ballistic missiles, has at least indirect implications for U.S. security, and is closely watched by U.S. policy-makers, including those in DoD and DoN (see project summary, below). The research is relevant to several courses in the NSA department, including NS 3530 (U.S. Interests in Latin America), NS 3520 (International Relations and Security Problems of Latin America), and NS 4250 (Problems of Security Assistance and Arms Transfer).

SUMMARY: The purpose of my research project was to assess Brazil's missile and nuclear capabilities and to analyze their implications for regional and hemispheric security, especially as they relate to U.S. interests. Brazil has successfully launched a series of rockets and is now developing a ballistic missile that could be topped with nuclear warheads. It has also succeeded in enriching uranium, and is expected to have the capacity to build nuclear weapons by the mid-1990s. These development could pose a serious threat to (a) Western Hemispheric security, in that the intermediate-range ballistic missiles being developed by Brazil could reach any country in South America; (b) U.S. security in the Middle East and Mediterranean, given Brazil's pattern of arms trade with countries such as Libya and Iraq; and (c) direct U.S. security, because a long-range ballistic missile being developed by Brazil could reach the United States.

NUCLEAR ASSESSMENTS

J. J. Tritten, Associate Professor of National Security Affairs; R.N. Channell, Adjunct Research Professor, National Security Affairs; E. M. Alvarez, Adjunct Research Instructor, National Security Affairs; S. A. Garrett, Adjunct Research Professor, National Security Affairs; K. M. Kartchner, Assistant Professor, National Security Affairs; M. Tsypkin, Assistant Professor, National Security Affairs; T. B. Grassey, Associate Professor, National Security Affairs; J. S. Breemer, Adjunct Professor, National Security Affairs; C. A. Buss, Adjunct Professor, National Security Affairs; E. A. Olsen, Professor of National Security Affairs

Sponsor:Defense Nuclear Agency (DNA).

OBJECTIVE: Use of RAND Strategy Assessment System (RSAS) to analyze role of strategic nuclear forces including impact of INF Treaty and SDI on strategy. Multi-year project.

SUMMARY: Work is in four main areas; the implication of the new INF Treaty on NATO, the U.S., and naval strategy; the integration of theater and strategic nuclear forces; SDI and strategy; and the role of the nuclear reserve force.

PUBLICATIONS: S.A. Garrett, "NATO Deterrence and Defense After the INF Treaty," NPS-56-89-010, June 1989, 110 p.

J.J. Tritten and R.N. Channell, "The RAND Strategy Assessment System at the Naval Postgraduate School," NPS-56-89-011, June 1989, 75 p.

K.M. Kartchner, "Issues and Options for Post-START Secure Reserve Forces (U)," NPS-56-89-001-PR, July, 35 p.

K.M. Kartchner, "Summary of National Policy Guidance for Secure Reserve Forces (U)," NPS-56-89-013-PR. August 1989, 16 p.

D.L. Bradford, "On-Site Inspection as an Enhancement to Verification," NPS-56-89-014, August 1989, 53 p.

J.J. Tritten, "Naval Arms Control: An Idea Whose Time Has Yet to Come," NPS-56-89-015, August 1989, 23 p.

CONFERENCE PRESENTATIONS: J.J. Tritten and R.N. Channell, "The RAND Strategy Assessment System at the Naval Postgraduate School," presented at the Joint National Meeting of the Operations Research Society of America (ORSA) and The Institute of Management Sciences (TIMS), Vancouver, British Columbia, May 1989.

J.J. Tritten, "Naval Arms Control," Presented to National Security Studies Program at California State University, San Bernardino, CA, April 1989.

J.J. Tritten, "Naval Arms Control," presented to the National Defense University Strategic Concepts Development Center, Washington, D.C., April 1989.

J.J. Tritten, "Naval Arms Control: An Idea Whose Time Has Yet to Come," presented to Atlantic Council NATO Youth Exchange Program, Naval Station Treasure Island, San Francisco, CA, September 1989.

THESES DIRECTED: Complications of Nuclear Free Zones in the International System," Master's Thesis, December 1988.

C.K. Reece, "The RAND Strategy Assessment System as a Decision Support System for Nuclear Command, Control, and Communications Net Assessment," Master's Thesis, March 1989.

R.K. Myers, "Political and Technical Verification Issues of Limitations on Sea-Launched Cruise Missiles," Master's Thesis, March 1989.

M.K. Johnston, "The Political Utility of Nuclear Weapons in Nuclear War Termination," Master's Thesis, June 1989.

J.A. Greene, "The Nuclear Threat to the Carrier Battle Force: The Problem and the Alternatives," Master's Thesis, June 1989.

A. Leary, "Optimizing the Post-START U.S. Strategic Nuclear Force Mix," Master's Thesis, June 1989.

D.C. Hulse, "Land Attack Cruise Missiles and Naval Strategy," Master's Thesis, December 1989.

J.R. Anderson, "Alternative Futures and the Role of the Navy in U.S. Nuclear Strategy," Master's Thesis, December 1989.

RELATIONSHIP OF WAR AT SEA TO WARFARE ASHORE

J. J. Tritten, Associate Professor, National Security Affairs,; R. N. Channell, Adjunct Research Professor, National Security Affairs; R.H.S. Stolfi, Professor, National Security Affairs; T. B. Grassey, Associate Professor, National Security Affairs; W. P. Hughes, Adjunct Professor, Operations Research; J. S. Breemer, Adjunct Professor, National Security Affairs; S. W. Blandin, Professor Emeritus, National Security Affairs.

Sponsor: Office of the Chief of Naval Operations (OP-603).

OBJECTIVE: Use of RAND Strategy Assessment System (RSAS) to analyze impact of execution of maritime strategy on land campaigns in Europe. Multi-year project.

SUMMARY: Primary emphasis has been on analyzing and providing an evaluation of the naval models in the RSAS to OPNAV, RAND, and OSD/NA. Research team has become familiar with how to operate the RSAS and has installed sufficient components to permit analysis and limited gaming in support of teaching. Assistance has been provided to Naval War College and other new RSAS users.

PUBLICATIONS: J.J. Tritten, "Withholding and Attacking SSBNs," Naval Forces, Vol. IX, No. II/1988, p. 44-51.

n, "Modern Sea Power," by Geoffrey Till, U.S. Naval Institute Proceedings Vol. 114, No. 12, December 1988, p. 142 (book review).

J.J. Tritten, "Strategic Antisubmarine Warfare," The Submarine Review, January 1989, p. 40-48.

J.J. Tritten, "Back to Basics: Mahan for the 1990s," NPS-56-89-003, February 1989, 23 p.

P.T. Fennell, "U.S. Navy Strategy: Offensive Strike or Escort?" NPS-56-89-006, February 1989, 19 p.

J.J. Tritten, "Naval Arms Control: An Idea Whose Time Has Yet to Come," NPS-56-89-015, August 1989, 23 p.

J.J. Tritten, "Is Naval Warfare Unique?" The Journal of Strategic Studies, December 1989 (forthcoming).

CONFERENCE PRESENTATIONS: J.J. Tritten, "Withholding and Attacking SSBNs," presented at the 14th Defense Advanced Research Projects Agency (DARPA) Strategic Systems Symposium, Naval Postgraduate School, Monterey, CA, October 1988.

J.J. Tritten, "Is Naval Warfare Unique?" presented to the MITRE Corporation, McLean, VA, October 1988.

R.H.S. Stolfi, "Soviet Naval Operational Art: The Soviet Approach to Naval War Fighting," presented to the MITRE Corporation, McLean, VA, October 1988.

J.J. Tritten, "Naval Arms Control," presented to National Security Studies Program at California State University, San Bernardino, CA, April 1989.

J.J. Tritten, "Naval Arms Control," presented to the National Defense University Strategic Concepts Development Center, Washington, D.C., April 1989.

J.J. Tritten, "Naval Arms Control: An Idea Whose Time Has Yet to Come," presented to Atlantic Council NATO Youth Exchange Program, Naval Station Treasure Island, San Francisco, CA, September 1989.

THESES DIRECTED: L.D. Marquet, "The Strategic Employment of the Soviet Submarine Force," Master's Thesis, December 1988.

M.K. Johnston, "The Political Utility of Nuclear Weapons in Nuclear War Termination," Master's Thesis, June 1989.

B.A. Ditzler, "Naval Diplomacy Beneath the Waves: A Study of the Coercive Use of Submarines Short of War," Master's Thesis, December 1989.

STRATEGIC MANAGEMENT FOR THE DEFENSE DEPARTMENT

J.J. Tritten, Associate Professor, National Security Affairs; N.C. Roberts, Associate Professor, Administrative Sciences, D. Whitt, Associate Professor, D. R.M.E.C. (DRMEC).

Sponsor: Director Net Assessment (OSD/NA), OSD/Competitive Strategies Office, Office of the Under Secretary of Defense - Acquisitions/Directorate for Program Integration, Strategic Planning Branch, and Director of Defense Policy on the National Security Council (NSC) Staff.

OBJECTIVE: This project is designed to conduct historical and current research and analysis in the area of strategic management for the DoD. This research will examine two separate areas: first, strategic planning with the goal to define DoD philosophy and mission, to establish long- and short-range objectives for the DoD, and to select strategies to be used in achieving those objectives; and second, strategic implementation with the goal to develop an organizational strategy, create functional activities necessary to support the strategy, and design control systems to monitor the effectiveness of the strategy in achieving DoD objectives. Multi-year project.

SUMMARY: The investigators have researched the subject area by visiting businesses and government agencies that have strategic planning staffs and programs, interviewing civilian and military personnel connected with the varying aspects of strategic management within DoD, and sought the cooperation of industrial leaders in the project. They have revised two courses in strategic planning and strategic management for the National Security and Administrative Sciences Departments and routinely offer these revised courses. They have developed initial historical cases for use in these courses; e.g. one on the Maritime Strategy and other on Hyman Rickover as an example of a public sector entrepreneur.

PUBLICATIONS: J.J. Tritten, "Defending America's Security," by Frederick Hartmann and Robert Wendzel, The Friday Review of Defense Literature, No. 88-38, 28 October 1988, p. 4-5 (book review).

N.C. Roberts and P.J. King, "The Stakeholder Audit Goes Public," Organizational Dynamics, Winter 1989, p. 63-79.

J.J. Tritten and N.C. Roberts, "Strategic Management or Strategic Planning for Defense?" NPS-56-89-002, February 1989, 34 p.

D.G. Wegmann, "Net Technical Assessment" NPS-56-89-008, March 1989, 47 p.

R.T. Bradley and N.C. Roberts, "Network Structure From Relational Data: Measurement and Inference in Four Operational Models," Social Networks, Vol. 11, No. 2, 1989, p. 89-134.

N.C. Roberts and P.J. King, "The Process of Public Policy Innovation," Research on the Management of Innovation, Andrew Van de Ven, Harold L. Angle, and Marshall Poole, Eds., New York, New York: Harper & Row, 1989, p. 303-335.

R.T. Bradley and N.C. Roberts, "Relational Dynamics of Charismatic Organization: The Complementarity of Love and Power," World Futures, Vol. 27, p. 1-37.

J.M. Kenny, "The Dibb Report: Three Years After," NPS-56-89-016, August 1989, 70 p.

CONFERENCE PRESENTATIONS: N.C. Roberts and P.J. King, "Public Entrepreneurship: A Typology," Academy of Management, Washington, D.C. August 1989.

N.C. Roberts, "Strategy-Making Process," Joint Staff (J-5) Strategy Division, Washington, D.C., August 1989.

THESES DIRECTED:R.D. Konecny, "Net Assessment: An Examination of the Process and Recommendations for Practical Application," M.S., December 1988.

R.D. Kropp, "JCS Planning: Assessment and Recommendations," M.S., September 1989.

N.L. Tanner & N.K.S. Young-Aranita, "Naval Postgraduate School: An Organizational Assessment," M.S., September 1989.

M.C. Vitale, "Analysis of the Competitive Strategies Methodology," M.S., December 1989.

M.J. Leahey, "History of Defense Peform From 1970-1989," M.S, December 1989.

W.S. Jesson & T.L. Hilliker, "Strategic Management in the Marine Corps," M.S., December 1989.

D.J. Wilson, "Defense Policy Management Program: A Feasibility Study," M.S., December 1989.

R.K. Knapper, "The United States Marine Corps Information Blockage A Case Study," M.S., Dec. 89.

THE MARITIME STRATEGY DEBATE

J.J. Tritten, Associate Professor of National Security Affairs
J.S. Breemer, Adjunct Professor of National Security Affairs
K.M. Kartchner, Assistant Professor, National Security Affairs
Sponsor:Office of the Chief of Naval Operations (OP-603).

OBJECTIVE: Preparation of annotated bibliography on the Maritime Strategy.

SUMMARY: Investigators prepared annotated bibliographies of books, articles, and journals dealing with the Maritime Strategy.

PUBLICATIONS: J.J. Tritten, Ed., "Report on Maritime/Joint Strategic Planning Journals," NPS-56-89-017, September 1989, 30 p.

P.M. Swartz & J.S. Breemer, "The Maritime Strategy Debates: A Guide to the Renaissance of U.S. Naval Strategic Thinking in the 1980s," NPS-56-89-019, September 1989, 126 p.

ANALYSIS OF WAR GAMES

J.J. Tritten, Associate Professor of National Security Affairs
R.B. Bathurst, Adjunct Research Professor of National Security Affairs
Sponsor: Director Net Assessment, Office of the Secretary of Defense (OSD/NA).

OBJECTIVE: Analysis of fourteen Nuclear Strategy DevelopMent Group (NSDG) seminar games, preparation of lessons learned, analysis of methodology, presentation of results, preparation of research design for next series.

SUMMARY: Prepared research designs for NSDG games 9-14 and supervised the conduct of those games and the preparation of lessons learned during 1985-1986. This project ensured analysis of final games and the entire series of games.

CONFERENCE PRESENTATIONS: J.J. Tritten, "Scenarios, Simulations and Games," presented at the Joint National Meeting of the Operations Research Society of America (ORSA) and The Institute of Management Sciences (TIMS), Denver, Colorado, October 1988.

J.J. Tritten, "Scenarios, Simulations and Games, presented at the 27th Annual Conference of the North American Simulation and Gaming Association, Ashville, North Carolina, October 1988.

J.J. Tritten, "Withholding and Attacking SSBNs," presented at the 14th Defense Advanced Research Projects Agency (DARPA) Strategic Systems Symposium, Naval Postgraduate School, Monterey, CA, October 1988.

J.J. Tritten, "Scenarios, Simulations and Games," presented to the Defense Language Institute, Monterey, CA, March 1989.

J.J. Tritten, "Are Nuclear and Non-Nuclear War Related?" 4th Conference on Crisis Stability and the Offense/Defense Relationship: New Leadership - New Directions, sponsored by the Arms Control and Disarmament Agency (ACDA), the Strategic Defense Initiative Organization (SDIO), the Defense Nuclear Agency (DNA), the Department of Energy (DOE), and the Office of the Assistant Secretary of Defense for International Security Policy, Monterey, CA, August 1989.

RESTRUCTURING THE SOVIET NAVY: THE PERSONNEL DIMENSION

M. Tsypkin, Assistant Professor of National Security Affairs
Sponsor: Naval Operations Intelligence Center/Navy Direct Funding

OBJECTIVE: Investigate the impact of Gorbachev's "restructuring" on personnel policies in the Soviet navy.

SUMMARY: The Soviet navy does not have enough competent personnel for handling the increasingly sophisticated technology. The officers are poorly motivated financially; the enlisted men suffer from various social and demographic problems. The Soviet defense industry is failing to provide the navy with reliable modern technology. The Soviet navy cannot solve all these problems until it reduces its size, which would allow them to be more selective in personnel policies, use released resources to create better conditions for personnel, and to improve the quality of ships and weapons.

PUBLICATIONS: Mikhail Tsypkin, "Men and Technology in Today's Soviet Navy," Forthcoming.

Mikhail Tsypkin, "Soviet Navy: Implications of Quality Problems for Arms Reductions," Submitted.

M. Tsypkin, "Will the Soviet Navy Go Volunteer?" Forthcoming.

GLASNOST AND SECRECY IN THE SOVIET MILITARY

M. Tsypkin - Assistant Professor, Department of National Security Affairs
Sponsor: Undersecretary of Defense/Acquisitions,
Joint Application Study Group

OBJECTIVE: Establish the degree to which Gorbachev's glasnost' (openness) has reduced the degree of genuine secrecy in the Soviet military and eliminated the danger of deception and no-compliance with arms control agreements.

SUMMARY: Glasnost' has eliminated the more absurd excesses of secrecy in Soviet military affairs, and made the Soviet system of state secrecy more rational in the age of satellite intelligence. In the short term the Soviets are unlikely to conduct strategic deception operations, although their bureaucratic culture is so prone to deception that compliance with arms control agreements might be complicated. In the longer term, the political instability in the Soviet Union and the growing anti-Western sentiment in a nascent Russian nationalist movement are likely to reduce the degree of military glasnost'.

PUBLICATIONS: M. Tsypkin, "Glasnost' and Secrecy in the Soviet Military," Forthcoming.

STRUCTURAL FACTORS IN THE LONG-TERM COMPETITION

D.S. Yost - Associate Professor of National Security Affairs
Sponsor: Under Secretary of Defense for Policy

OBJECTIVE: The original proposal of April 1986 outlined a rather vast project. In practice, the research monitor -- the Director of Net Assessment in the Office of the Secretary of Defense -- has encouraged me to concentrate on security issues relating to Western Europe, including West European views on certain critical topics, and on broad political trends in Western societies, especially with respect to nuclear deterrence.

SUMMARY: An important part of the research has consisted of interviews with West European officials and experts about contemporary security problems. This part of the research has to date resulted in the preparation of 19 reports to the Director of Net Assessment (of which 10 were prepared during the January 1989-December 1989 period). The Director of Net Assessment regards these reports, which are unclassified, as sensitive and unsuitable for reproduction or circulation because of their political content. These reports have therefore been retained on a close-hold basis by the Director of Net Assessment and the Director of Policy Research in OSD. Please see the attached letter from Lt Col Fred Littlepage, USAF, Assistant Director for Research in the Office of Net Assessment, dated 28 April 1989, for judgment regarding the value of this research.

In conjunction with this research, I was invited to be part of a U.S. Department of Defense delegation for talks with the French Ministry of Defense in May 1989, and made a presentation regarding American views on the security implications of European economic integration after 1992. Finally, the research has also supported the preparation of publications such as my article, "La France et al securite europeenne: un point de vue americanin," Defense Nationale, vol. 45 (October 1989), pp. 39-56.

This project is more than a vehicle for furnishing the Office of the Secretary of Defense with information and analysis about political perceptions in Western Europe regarding specific security topics. Its underlying purpose remains unchanged: to throw light on critical structural factors since the long-term East-West competition. It has been most valuable in enhancing my ability t o teach various courses at NPS.

DEPARTMENT
OF
OCEANOGRAPHY

DEPARTMENT OF OCEANOGRAPHY

NEARSHORE STUDIES

Professors E. B. Thornton, C. S. Wu, and N. Dodd are measuring and developing models of nearshore wave dynamics. Models have been developed to describe wave transformation and mean longshore currents. Shear waves developed due to instability of the wave induced longshore current is shown to be responsible for turbulent mixing in the nearshore. The technical sponsor for the work is ONR.

COASTAL OCEAN STUDIES

Prof. M. L. Batteen is using a primitive equation ocean model to understand the effects of wind forcing and topography on Eastern Boundary Currents. The technical sponsor for the work on the California Current is ONR and for the work on the Leeuwin Current is NSF.

Prof. S. R. Ramp has been a participant in two projects. The purpose of the "Coastal Transition Zone" project is to improve our understanding of the formation of cold filaments which extend offshore from coastal upwelling regions. Prof. Ramp organized several cruises to the study region and supervised the collection of hydrographic data. Prof. Ramp also has a project underway to study the currents on the shelf and slope off Pt. Sur. The technical sponsor for this work is ONR.

Prof. J. A. Nystuen has completed a study of the difference in satellite derived wind speed measurements from passive microwave (SSM/I) and altimeter (GEOSAT) satellite platforms.

Prof. J. A. Nystuen and Prof. R. W. Garwood are studying the formation of a rain-induced turbulent layer at the ocean surface. Prof. J. A. Nystuen has developed a theory to explain how a rain induced surface layer will affect surface gravity waves. The technical sponsor is ONR.

Prof. C.A. Collins and Prof. N. Garfield are studying the kinematics of the currents across the continental margin off Pt. Sur using velocity sounding techniques. The sponsor for this study was ONR and NPS.

Prof. P. Chu and Prof. C. A. Collins carried out observations of the upper ocean current structure off San Clemente. The sponsor for this study was the Naval Engineering Systems Command.

OCEAN REMOTE SENSING

Prof. E. B. Thornton is using interferometric SAR (two doppler radars mounted on an airplane) to study the surface velocity field, including that due to ocean currents, wind and capillary waves. This new techniques is shown to give unambiguous surface elevation spectra, superior to conventional SAR. The technical sponsor for these studies is ONR.

Prof. N. Garfield and Prof. L. Rosenfeld began a study of Monterey Bay circulation processes using AVHRR data.

OPEN OCEAN STUDIES

Under sponsorship of the NSF, Prof. A. J. Semtner, Jr., completed a numerical simulation of global ocean circulation with mesoscale resolution. This calculation has established the feasibility of ocean prediction using modern large-scale computers. A new calculation with time-varying forcing is underway.

Prof. D. C. Smith, IV completed a study of how motion is induced in ocean eddies by their interaction with several environmental factors such as an adjacent current, lateral boundary or topography. The sponsor for the study is ONR.

Prof. T. P. Stanton and Prof. E. B. Thornton are studying the properties of velocity shears and density gradients in the upper ocean. A towed package and coherent and incoherent doppler velocimeters have been developed to measure finescale shear and turbulent microstructure. Observations were collected during two cruises. The research is sponsored by ONR.

Prof. R. W. Garwood, Jr., and Prof. P. Chu are sponsored by the NPS Research Foundation, ONR and NSF to investigate the thermodynamic and dynamic coupling between the oceanic and atmospheric turbulent boundary layers. A new mechanism for feedback between the oceanic mixed layer and cloud formation in the tropics has been discovered and studied. Also, an entrainment model has been used to explain the deep penetration of turbulence into the equatorial undercurrent.

ARCTIC STUDIES

Professors R. H. Bourke and R. G. Paquette are involved in studies of the frontal and finestructure phenomena associated with the ice edges of the Atlantic and Pacific Oceans as well as studies of Arctic sea ice. These studies have applications for environmental acoustics and under-ice submarine operations. Most recently they have studied the charactertics of the Jan Mayen Current as part of the Greenland Sea Project. The sponsor is the Arctic Submarine Laboratory.

Prof. D. C. Smith IV began a study of how ocean eddies in the marginal ice zone would be influenced by an along-ice edge current and continental slope topography. ONR is the sponsor for this study.

Prof. A. J. Semtner, Jr., completed studies of the atmospheric forcing and sea-ice response in a coupled ice-ocean model. These studies were sponsored by the NSF.

Prof. C-S Chiu developed an inversion code for the analysis of the Greenland Sea tomography array data which will become available soon. This research was sponsored by the Research Council.

ENVIRONMENTAL ACOUSTICS

Profs. C-S Chiu and A. Semtner are investigating acoustic propagation over very long distances using the output of a global eddy-resolving ocean model.

Prof. C-S Chiu completed an examination of the 3-d environmental effects on sound propagation through the Gulf Stream. This research was sponsored by the Research Council.

Prof. J. A. Nystuen is developing techniques for measuring air/sea interaction at sea through ambient sound measurements. He carried on a study of precipitation generated ambient sound in winter storms off the Coast of Nova Scotia. His research is technically sponsored by ONR.

Prof. J. A. Nystuen is developing techniques for monitoring air/sea interaction processes at sea through ambient sound measurements. He is continuing to analysis the small scale physics of sound production by raindrops. He is continuing efforts to develop an acoustic ocean drifting buoy to acoustically monitor the ocean in conjunction with satellite measurements. The technical sponsor is NOARL.

Prof. R. H. Bourke continued studies of the ambient noise generated in arctic ice-covered waters based on noise measurements acquired by drifting buoys. The sponsor is the Arctic Submarine laboratory.

MARINE OPERATIONS

Prof. C. A. Collins and Mrs. N. A. McGee provided shipboard support for NPS at-sea research projects off the Central California coast. Seventy-five days of operations were carried out on the R/V Pt. Sur and an additional thirty-seven days at sea were supported on other research vessels including on the USNS DeSteiger, USNS Bartlett, and R/V Ricketts; students and faculty participating included the Department of Oceanography, Meteorology, and Physics. The sponsor for this project is the Commander, Naval Oceanography Command.

Professors R. W. Garwood, Jr., S. R. Ramp, C. A. Collins continued the development of a Physical Oceanographic Observation Laboratory through the acquisition of current meters and acoustic releases. The technical sponsor for the research part of this project is ONR.

MODELING STUDIES OF THE EASTERN BOUNDARY CURRENT FLOW OFF WESTERN AUSTRALIA

M.L. Batteen - Associate Professor of Oceanography
Sponsor: National Science Foundation

OBJECTIVE: The objectives of this project are to investigate (1) why the eastern boundary flow off Western Australia (W.A.) is generally poleward rather than equatorward, and (2) why mesoscale eddies are present in this region. To accomplish these goals, we propose to (1) adapt an existing primitive equation (PE) ocean model presently being used in the eastern boundary flow region off California to the eastern boundary flow region of W.A.; (2) incorporate different initial conditions appropriate for the W.A. region into the model: and (3) run a series of numerical model experiments using the different initial conditions. Analysis of the results from each experiment should determine under what conditions a poleward flow (called the Leeuwin Current) and/or mesoscale eddies are generated. The ultimate goal is to provide the physical understanding necessary for high resolution ocean prediction in this region.

SUMMARY: Different numerical model experiments in a regional primitive equation Ocean model are being run to investigate the eastern boundary flow off W.A. Particular attention is being given to investigating (1) why the flow is generally poleward rather than equatorward as in other eastern boundary currents and (2) why there are mesoscale eddies present. The role of thermal forcing study has been completed, while the combined roles of wind and thermal forcing study is ongoing.

PUBLICATIONS: Batteen, M.L. and M.J. Rutherford, "Modeling Studies of Eddies in the Leeuwin Current," J. Phys. Oceanogr., Submitted.

Batteen, M.L. and M.J. Rutherford, "A Numerical Modeling Study of the Leeuwin Current Eddy Field," Trans. Am. Geophys. Union, 70, 1140, 1989.

Batteen, M.L. and M.J. Rutherford, "Numerical Studies of the Leeuwin Current," Research Activities in Atmospheric and Oceanic Modeling, WMO/JSC Working Group on Numerical Experimentation, 12, in press.

Rutherford, M.L. and M.L. Batteen, "Modeling Studies of the Leeuwin Current Using a High-Resolution Primitive Equation Model," Naval Postgraduate School Technical Report. NPS 68-89-010, 189 pp.

CONFERENCE PRESENTATIONS: Batteen, M.L., "Numerical Modeling Study of Leeuwin Current Eddy Field," American Geophysical Union (AGU) Fall Meeting, San Francisco, CA., 4-8 December.

THESIS DIRECTED: M.J. Rutherford, LCDR, Australian Navy, "Modeling Studies of the Leeuwin Current Using a High-Resolution Primitive Equation Model," M.S., September 1989.

WIND FORCING EFFECTS ON EDDIES AND JETS IN THE CCS

Mary L. Batteen - Associate Professor of Oceanography
Sponsor: Direct Funded Sponsor: Office of Naval Research

OBJECTIVE: The objective of this project is to understand the role of wind forcing in eddy and jet formations in the CCS (California Current System). To accomplish these goals we proposed to (1) incorporate wind forcing into an existing primitive equation (PE) model of the California Current, (2) vary the type of wind forcing and (3) compare the results with observations.

SUMMARY: Wind forcing has been incorporated into the model with the additional model development of including surface heating to prevent continuous cooling nearshore when coastal upwelling occurs. The effects of wind forcing have been analyzed by varying the type of wind forcing. In particular, we have focused on cases of steady, southward winds, with and without the curl, in a flat bottom ocean. Preliminary results show the development of eddies and jets. Model improvements in these studies are to incorporate time-dependent wind data and finer horizontal resolution (to look at fronts).

PUBLICATIONS: Batteen, M.L., R.L. Haney, T.A. Tielking and P.G. Renaud, "A Numerical Study of Wind Forcing of Eddies and Jets in the California Current System," J. Mar. Res., 47 (3), 493-523.

Batteen, M.L., C.N.K. Mooers and A.A. Bird, "Effects of Sampling Strategies in Space and Time on Representation of Mesoscale Variability in the California Current System," J. Geophys. Res., Submitted.

Batteen, M.L., "Mean Flow Instability and Topographic Influences on Eddy Formation in the Central California Current System," J. Geophys. Res., Submitted.

Batteen, M.L., "Model Simulations of a Coastal Jet and Undercurrent in the Presence of Eddies and Jets in the California Current System," Springer-Verlag Coastal and Estuarine Studies on Poleward Flows along Eastern Boundaries, 263-279, 1989.

Batteen, M.L., C.S. Nelson, R.W. Edson, C.N. Lopes da Costa and M.J. Rutherford, "Modeling Studies of Eastern Boundary Coastal Circulations," Poster T3.ML.01, The Oceanography Society Inaugural Meeting, 43-44.

Batteen, M.L. and C.N. Lopes da Costa, 1989: "Numerical Studies of the Portugal Eastern Boundary Current System and Research Activities in Atmospheric and Oceanic Modeling," WMO/JSC Working Group on Numerical Experimentation, 12, in press.

Batteen, M.L. R.W. Edson and C.S. Nelson, "Effects on Spatially Varying Winds on the Central CCS," Trans. Am. Geopys. Union, 70, in press.

Nelson, C.S. and M.L. Batteen, "Wind Forcing of Coastal Circulation Off Northern Baja California," Trans. Am. Geophys. Union, in press.

Edson, R.W., M.L. Batteen, and C.S. Nelson, "The Effects of Climatological and Transient Wind Forcing on Eddy Generation in the California Current System," Naval Postgraduate School Technical Report. NPS 68-89-008, 139 pp.

Lopes da Costa, C.N., M.L. Batteen, and C.S. Nelson, "A Numerical Study of Wind Forcing in the Eastern Boundary Current System Off Portugal," Naval Postgraduate School Technical Report. NPS 68-89-007, 114 pp., 1989.

Gunderson, C.R., M.L. Batteen, and C.S. Nelson, "Saline Impact on the California Current System," Naval Postgraduate School Technical Report. NPS 68-89-006, 108 pp., 1989.

Batteen, M.L., "Review of Facts on File in Marine Science," Am. Met. Soc. Bull., in press.

Batteen, M.L., "Review of The Baroclinic Circulation of the West Spitsbergen Current," Springer-Verlag Coastal and Estuarine Studies on Poleward Flows along Eastern Ocean Boundaries, 66-67, 1989.

CONFERENCE PRESENTATIONS: M.L. Batteen, "Modeling Studies of Eastern Boundary Coastal Circulations," The Oceanography Society Inaugural Meeting, Monterey CA, 27-30 August.

M.L. Batteen, "Mesoscale Modeling of Eastern Boundary Coastal Regimes: A Time and Space Challenge," Mesoscale Interactive Air - Sea Coupling Workshop, Monterey, CA, 31 August - 1 September

THESIS DIRECTED: C.R. Gunderson, LCDR, US Navy, "Saline Impact on the California Current," 1989.

WIND FORCING EFFECTS ON EDDIES AND JETS IN THE CSS, (CONT)

C.N.L da Costa, LCDR, Portugal Navy, "A Numerical Study of Wind Forcing in the Eastern Boundary Current System off Portugal," M.S., September 1989.

R.W. Edson LT, US Navy, "The Effects of Climatological and Transient Wind Forcing on Eddy Generation in the California Current System," M.S., September 1989.

CHAIR IN ARCTIC MARINE SCIENCE

Robert H. Bourke, Professor of Oceanography
Sponsor: Office of Naval Research

OBJECTIVE: To foster oceanographic research in the Arctic, acquaint naval officer students with Arctic problems, reduce results of pure research to operational usage, and publicize Navy interest in the Arctic.

SUMMARY: Professor Bourke served as administrator of the Chair handling such details as selecting Chair candidates, writing IPA's and proposals and setting up visits and seminars for the Chair incumbent. Prof. Arne Foldvik of the University of Bergen, Norway was the Chair incumbent during FY89. He had a productive year at NPS providing seminars, lectures, writing papers and attending conferences. He analyzed data from a recent Greenland Sea Project (GSP) cruise and participated in another (June 1989). He convened a workshop at NPS bringing together GSP participants to discuss recent findings from the intensive field measurements acquired during 1988 and 1989. He acted as thesis advisor for a Master's student studying the differences in the deep water formation processes of the Weddell and Ross Seas. He completed two papers, one examining the tides of the Weddell Sea and another using isotope tracers to examine the water/ice interaction of the shelf waters of the Weddell Sea.

MARGINAL SEA-ICE ZONE STUDIES 1989

Robert H. Bourke, Professor of Oceanography
Robert G. Paquette, Emeritus Professor of Oceanography
Sponsor: Arctic Submarine Laboratory

OBJECTIVE: Carry out physical oceanographic research, including field measurements, in the marginal sea-ice zone of the Bering, Chukchi, and Greenland Seas. This work has the long-term applied objective of facilitating the operation of submarines under ice. It is part of the continuing MIZPAC and MIZLANT programs.

SUMMARY: This is an ongoing program to study the frontal and fine structure phenomena associated with the ice edges of the Atlantic and Pacific Oceans. Measurements, primarily CTD lowerings, have been carried out from ice breakers since 1971 and include observations both in summer and winter. During FY89 as part of the international Greenland Sea Project (GSP), we conducted a cruise in September 1989 to the southern Greenland Sea to observe the flow characteristics of the Jan Mayen Current and the deep water formation in the Greenland and Norwegian Seas. Initial data editing is completed and a preliminary cruise report has been prepared. Analysis of underice ambient noise from drifting buoys in the Canadian Basin has been completed. The noise field in summer is now being investigated with respect to the summertime Beaufort Gyre reversal. The initial underice propagation loss model, ICECAP, was evaluated for use in the marginal ice zone and found to be unsatisfactory, especially in winter. Work is in progress to create an Arctic Ocean atlas of underice roughness parameters (standard deviation of ice thickness, mean keel draft and keel frequency) suitable for use in underice acoustic propagations models.

PUBLICATIONS: R. H. Bourke and R. G. Paquette, "Estimating the Thickness of Sea Ice," J. Geophys. Res., 94(C1), 919 - 923, 1989.

R. H. Bourke, V. G. Addison, R. G. Paquette, "Oceanography of Nares Strait and Northern Baffin Bay in 1986 with Emphasis on Deep and Bottom Water Formation," J. Geophys. Res., 94(C6), 8289 - 8302, 1989.

R. H. Bourke, D. L. Poffenberger, and J. H. Wilson, "Ambient Noise in the Greenland Sea," to be published in April 1989 issue of US Navy J. Underwater Acoustics, (Confidential).

R. H. Bourke, J. M. Curtis, R. A. Lawson, and C. R. Dunlap, "Undersea Ambient Noise in the Norwegian Sea," to be published in Jan 1989 issue of U.S. Navy J. Underwater Acoustics (Confidential).

R. H. Bourke and A. M. Weigel, "The Baroclinic Circulation of the West Spitsbergen Current," in Poleward Flows Along Eastern Ocean Boundaries, ed., S.J. Neshyba, C.N.K. Mooers, and R. L. Smith, Springer - Verlag, New York, pp. 47 - 65, 1989.

R. H. Bourke, R. F. Blythe, and R. G. Paquette, "Preliminary Cruise Report of USNS BARTLETT to the Greenland Sea in September 1989," NPS 68-90-001, December 1989.

CONFERENCE PRESENTATIONS: R. H. Bourke, "The Jan Mayen Current," Greenland Sea Workshop, Monterey, CA, 15 - 16 Feb 1989.

R. H. Bourke, "Arctic Ambient Noise as Measured by Drifting Buoys," Arctic Technology Workshop, Hanover, NH, 20 - 23 June 1989.

R. H. Bourke, V. G. Addison, and R. G. Paquette, "Deep and Bottom Water Formation in Baffin Bay," Inaugural Meeting of The Oceanography Society, Monterey, CA, 28 - 30 August 1989.

R. H. Bourke, "Ambient Noise in the Arctic Ocean," Seminar at Geophysical Institute, Univ. of Bergen, Norway, 27 Sept 1989.

THESES DIRECTED: M. Z. Nordman, LT, USN, "An Analysis of Drifting Buoy Ambient Noise Data in the Beaufort Sea," M.S., March 1989. Also issued as NPS Tech. Rept. NPS 68-89-003.

C. J. Gallagher, "Acoustic Propagation Across the Greenland Marginal Ice Zone Using the ICECAP Model," M.S., March 1989. Also issued as NPS Tech. Rept. NPS 68-89-002.

THREE-DIMENSIONAL ACOUSTIC PROPAGATION MODELLING AND PREDICTION, AND ACOUSTIC TOMOGRAPHY

Ching-Sang Chiu, Assistant Professor of Oceanography

Sponsor: Research Council

OBJECTIVE: Quantification of 3-d environmental effects of fronts and eddies on sound propagation, investigation of the resolution required on the input sound speed field for accurate acoustic prediction, and development of inversion codes to integrate acoustic tomographic observations, in-situ data and remote sensing data from space for improved ocean field estimates.

SUMMARY: A three-dimensional (3-d) acoustic propagation model based on the coupled mode theory was developed by Chiu and Ehret prior to joining NPS. In this project, we have interfaced this acoustic model with a sound speed field generated by a Harvard University ocean forecast model in an effort to quantify the 3-d environmental effects on sound propagation through the intense Gulf Stream current system. Furthermore, we have conducted a study of the sensitivity of the model to the vertical resolution of the input sound speed field. The latter study was accomplished using an experimental data set from a CTD survey conducted southwest of Bermuda by the Ocean Tomography Group. In another part of this project, we have developed and tested a 3-d tomographic inversion code in preparation for the analysis of the Greenland Sea Acoustic Tomography data. This inversion code will be further upgraded to include the capability of blending acoustic observations with known ocean dynamics, as well as with supplementary in-situ data and remote sensing data from space to produce improved ocean field estimates.

PUBLICATIONS: C.-S. Chiu and L.L. Ehret, "Computation of Sound Propagation in a Three-Dimensionally Varying Ocean: A Coupled Normal Mode Approach," Proceedings of the Second IMACS Symposium on Computational Acoustics (edited by D. Lee, A. Cakmak, and R. Vichnevetsky), North-Holland, in press.

A.E. Newhall, J.F. Lynch, C.-S. Chiu, and J.R. Daugherty, "Improvements in Three-Dimensional Raytracing Codes for Underwater Acoustics," Proceedings of the Second IMACS Symposium on Computational Acoustics (edited by D. Lee, A. Cakmak, and R. Vichnevesky), North-Holland, in press.

C.-S. Chiu, "Acoustic Normal Mode Propagation Modelling Through the Oceanic Mesoscale," Chapter in Coupled Ocean Prediction and Acoustic Propagation Models, (editors: Robinson and Lee), Forthcoming.

CONFERENCE PRESENTATIONS: C.-S. Chiu and L.L. Ehret, "Computations of Sound Propagation in a Three-Dimensionally Varying Ocean: A Coupled Mode Approach," Second IMACS Symposium on Computational Acoustics, Princeton University, Princeton, New Jersey, March 15-17, 1989.

C.-S. Chiu and A.E. Newhall, "Improvements in Three-Dimensional Raytracing Codes for Underwater Acoustics," Lynch, and J.R. Daughtert, Second IMACS Symposium on Computational Acoustics, Princeton University, Princeton, New Jersey, March 15-17, 1989

THESIS DIRECTED: Chih-Chung Kao, LT, Taiwan Navy, "A Study of the Sensitivity of the Greenland Sea Acoustic Tomography Array," M.S, December 1989.

COMPUTER SIMULATION STUDIES OF LOW-FREQUENCY CROSS-BASIN ACOUSTIC TRANSMISSIONS

Ching-Sang Chiu, Assistant Professor, Department of Oceanography
Albert J. Semtner, Professor, Department of Oceanography
Sponsor: Office of Naval Research

OBJECTIVE: Modelling and analysis of cross-basin acoustic wavefields.

SUMMARY: This is a new two-year project started in October of this year. We are currently conducting computer simulation studies of acoustic transmissions across the Atlantic and across the Pacific. The transmissions are simulated by interfacing a three-dimensional acoustic propagation model with the Semtner-Chervin eddy-resolving global general circulation model. The calculations will be used to support the analysis/modeling of the field data to be obtained from a seven-day global transmission experiment in 1991. This field experiment was planned by Munk and Forbes and will evaluate the feasibility of their idea of detecting greenhouse warming from decadal measurements of acoustic travel time variability. These calculations will also give us a better understanding of the effects of mesoscale processes on cross-basin low-frequency sound propagation in support of Naval operations.

FEASIBILITY STUDY FOR A NORWEGIAN CONTINENTAL SHELF - BARENTS SEA ACOUSTIC TOMOGRAPHY EXPERIMENT

Ching-Sang Chiu, Assistant Professor, Department of Oceanography
James H. Miller, Assistant Professor, Department of EC&E
Sponsor: Office of Naval Research

OBJECTIVE: To examine the feasibility of conducting an acoustic tomography experiment in the Barents Sea - Norwegian Sea region

SUMMARY: This is a new project started in October of this year. The research, in collaboration with J.H. Miller of the EC&E Department, is a feasibility study of an acoustic tomography experiment off the coast of Norway. The goal of this experiment would be to study the large scale oceanographic processes in the Norwegian Sea and Barents Sea, an important area for Naval operation. In addition, long range underwater acoustic propagation will be studied in the area, particularly under-ice in the Barents Sea. This one year feasibility study involves: (1) detailed identification of the acoustic and oceanographic scientific issues, (2) analyses of available data to determine the temporal and spatial scales of the various ocean processes in the Barents and Norwegian Seas, (3) investigation of sound propagation using 3-D acoustic ray, mode or PE codes with realistic environmental data, (4) detailed modeling of the expected array performance, (5) research and development of the equipment needed for both the ocean experiment and shore-side signal processing, and (6) coordination with the anticipated experiment participants. Based on the results of this feasibility study, a multi-year, cost-shared proposal will be submitted to ONR and NPS.

COUPLED OCEANIC AND ATMOSPHERIC BOUNDARY LAYERS

Pecheng Chu, Adjunct Research Professor
Roland W. Garwood, Jr., Professor of Oceanography
Sponsor: NPS Direct Fund

OBJECTIVE: To provide a theoretical basis for ice drift prediction, which benefits the submarine activity in the polar regions.

SUMMARY: Based on the intensive survey on the feedback mechanism among three components (air, ice, and ocean) in the polar regions for the last several years, we found that the same mechanism is also valid for longer time-scale. The theoretical air-ice-ocean coupled model developed in this project shows a possible positive/negative feedback mechanism, induced by the hydrological cycle, among atmosphere, ice, and ocean. The theory predicts the generation of oscillations in ice-coverage, ice thickness, air and ocean temperatures, and sea level height.

PUBLICATIONS: Chu, P.C., "Air-Ice-Ocean Feedback Mechanism and Ice Oscillation on Millennial Time Scales," Annals of Glaciology, 14, in press.

CONFERENCE PRESENTATIONS: Chu, P.C., 1989. "Air-Ice-Ocean Feedback Mechanism and Glacial Cycles," Symposium On Ice and Climate, sponsored by the International Glaciological Society, Seattle, 20-25 August 1989.

COUPLED ATMOSPHERIC AND OCEANIC BOUNDARY LAYERS

Pecheng Chu, Adjunct Research Professor
Roland W. Garwood, Jr., Professor of Oceanography
Sponsor: Office of Naval Research

OBJECTIVE: To develop a comprehensive computer-based model for the analysis and prediction of naval oceanography.

SUMMARY: An intensive survey of a new feedback mechanism between the clouds and the oceanic mixed layer. It is found that clouds reduce the solar radiation at the ocean surface by scattering and absorption, which cools the ocean surface layer by increasing mixed layer entrainment. The cooling of the ocean mixed layer lowers the evaporation rate, which will diminish the clouds. This is a negative feedback mechanism. On the other hand, precipitation dilutes the surface salinity, stabilizing the upper ocean and reducing mixed layer deepening. The reduction in the mixed layer depth will increase the sea surface temperature by concentrating the net radiation plus heat fluxes downward across the sea surface into a thinner layer. The increase of sea surface temperature augments the surface evaporation, which in turn produces more clouds. This is positive feedback mechanism.

PUBLICATION: Chu, P.C., "Relationship Between Thermally Forced Surface Wind and Sea Surface Temperature Gradient," Pure & Appl. Geophys., 130, 31-45, 1989.

Chu, P.C., and R.W. Garwood, Jr., "Cloud-Ocean Mixed Layer Feedback," Role of Clouds in Atmospheric Chemistry and Global Climate, Amer. Meteor. Soc., 39-44, 1989.

Chu, P.C., and R.W. Garwood, Jr., "Thermodynamical Feedback Between Cloud and Ocean Mixed Layer," Adv. Atmos. Sci., 7, Springer-Verlag, New York, in press.

Chu, P.C., and R.W. Garwood, Jr., "Effects of Hydrological Cycle on the Air-Ocean Coupled System," Trans. Amer. Geophys. Union, 70, 297. 1989.

Chu, P.C., and R.W. Garwood, Jr., "Effects of Vertical Mixing and Entrainment on the Equatorial Air-Sea Coupled System", TOSIM, 11, 1989.

Chu, P.C., and R.W. Garwood, Jr., "Hydrological Effects on the Air-Ocean Coupled System," Proceedings, Western Pacific International Meeting and Workshop on TOGA/COARE, in press.

Chu, P.C., R.W. Garwood, Jr., and Muller, "Unstable and Samped Modes in Coupled Ocean Mixed Layer and Cloud Models," J. Marine Systems, 1, in press.

Garwood, R.W., Jr., P.C. Chu, P. Muller, and N. Schneider, "Equatorial Entrainment: The Diurnal Cycle," Proceedings, Western Pacific International Meeting and Workshop on TOGA/COARE, in press.

CONFERENCE PRESENTATIONS: Chu, P.C., and R.W. Garwood, Jr., "Cloud-Ocean Mixed Layer Feedback," Amer. Meteor. Soc. Meeting, Anaheim, CA, 30 January- 3 February, 1989.

Chu, P.C., and R.W. Garwood, Jr., "Hydrological Effects on the Air-Ocean Coupled System," International TOGA/COARE Conference, Noumea, New Caledonia, 24-30 May 1989.

Garwood, R.W., Jr., P.C. Chu, P. Muller, and Schneider, "Equatorial Entrainment: The Diurnal Cycle," International TOGA/COARE Conference, Noumea, New Caledonia, 24-30 May 1989.

Chu, P.C., R.W. Garwood, Jr., and P. Muller, "Unstable and Damped Modes in Coupled Cloud and Ocean Mixed Layer System," The 21st International Liege Colloquium on Ocean Hydrodynamics, Liege, Belgium, 8-12 May 1989.

Chu, P.C., and R.W. Garwood, Jr., "Importance of Cloud-Oceanic Mixed Layer Feedback in Ocean Prediction," Air Sea Conference, sponsored NOARL, Monterey, 31 August- 1 September 1989.

Chu, P.C., and R.W. Garwood, Jr., "Effects of Vertical Mixing and Entrainment on the Equatorial Air-Sea Coupled System," The Oceanography Inaugural Meeting, Monterey, 27-30 August 1989.

SAN CLEMENTE BASIN EXPERIMENT

Curtis A. Collins, Professor and Chairman of Oceanography
Pecheng Chu, Adjunct Research Professor of Oceanography
Sponsor: Naval Facilities Engineering Command

OBJECTIVE: By the use of Acoustic Doppler Current Profiler (ADCP) to measure the upper ocean velocity field in the San Clemente Basin to benefit the naval activity.

SUMMARY: The purpose of the San Clemente Basin Experiment (SCBE) was to survey the upper ocean in a region southwest of San Clemente Island. To accomplish this two cruises were made in this area during which currents were measured using a shipboard mounted Acoustic Doppler Current Profiler (ADCP). The first of these cruises took place in mid July 1989 and the second in early September 1989. After analyzing the data we collected, we found a transition zone between eddy dominant and longshore current dominant regions. The microstructures of the upper ocean in both regions are obtained.

PUBLICATIONS: Tsai, C.M., P. Jessen, P.C. Chu, and C.A. Collins, "Small-Scale Structure of California Currents from Combined XBT/ADCP Measurements," Trans. Amer. Geophys. Union, 70, 1156, 1989.

CONFERENCE PRESENTATIONS: Tsai, C.M., P. Jessen, P.C. Chu, and C.A. Collins, "Transition Between Eddy-Dominant and Longshore Current-Dominant Regions in the California Currents," Amer. Geophys. Union Fall Meeting, San Francisco, 4-8 December 1989.

OCEAN CURRENTS OFF SAN CLEMENTE

C. A. Collins, Professor and Chairman of Oceanography
Pecheng Chu, Research Professor of Oceanography
Sponsor: Naval Engineering Systems Command

OBJECTIVE: Develop representative upper ocean current profiles during summer for use with array maintenance activities.

SUMMARY: Surveys of the upper ocean velocity structure were conducted in San Clemente basin from the R/V Pt. Sur in mid July and early September 1989. Measurements were made by means of the hull mounted acoustic Doppler current profiler on the ship.

Data clearly show the presence of the Southern California eddy in the region. The eddy circulates water from the west and southwest into the Southern California bight. This results in relatively strong surface currents (approaching 0.5 m/s) flowing northward just to the west of San Clemente. In the region to the west of this strong northward flow, smaller scale eddies occur.

PUBLICATIONS: Tsai, C. M., P. Jessen, P. C. Chu and C. A. Collins, "Small Scale Structure of California Currents from Combined XBT/ADCP Measurements," Trans. Am. Geophys. Union 70, (70), p. 1156, 1989.

CONFERENCE PRESENTATIONS: Tsai, C. M., P. Jessen, P.C. Chu and C. A. Collins, "Small Scale Structure of California Currents from Combined XBT/ADCP Measurements," Fall National Meeting, American Geophysical union, San Francisco, 7 December 1989.

CALIFORNIA UNDERCURRENT STUDY

C. A. Collins, Professor and Chairman of Oceanography

Sponsor: Office of Naval Research

OBJECTIVE: To develop a better understanding of the kinematics and dynamics of the California Undercurrent.

SUMMARY: We have continued bimonthly surveys of the velocity field across the continental margin off Point Sur using an autonomous acoustically tracked velocity profiler called "Pegasus". Research cruises were carried out as follows: 2 - 7 February, 25 - 30 March, 28 July - 3 August, 25 - 30 September, and 15 - 22 November on the R/V Pt. Sur and 10 - 26 May on the USNS DeSteiger. The May cruise included placing and surveying additional transponders off Point Sur as well as additional hydrographic data collection northward to Pigeon Point. The quality of our data improved significantly in May when we received a new Pegasus instrument which includes additional channels and a CTD. The structure of the Undercurrent can vary significantly from one survey to the next. Nevertheless, it is always clearly present in approximately the same location and is seen in the annual mean to be located between 30 and 70 km offshore and between the surface and 600m. The core of the flow appears about 40 km off shore at a depth of 100 m. The flow is northwesterly close to the coast and veers to the north farther offshore. Not surprising, this reflects the pattern of the bathymetry. An influx of water occurs along the Undercurrent's offshore edge. To the west of 70 km offshore, currents are light and variable, but at about 100 km offshore, flow becomes northwesterly--this is the California current. There is evidence that the Undercurrent may be deeper in summer months.

CONFERENCE PRESENTATION: Rago, T. A. and C. A. Collins, "Measurements of Ocean Currents Across the Continental Margin off Pt. Sur, California, from April 1988 to March 1989," Trans. Am. Geophys. Union 70 (43), p. 1156, 1989.

Robson, A., C. A. Collins, and M. McCann, "Circulation of the California Undercurrent near Monterey," Trans. Am. Geophys. Union 70 430, p. 1156, 1989.

Berryman, P., T. Rago and C. Collins, "Velocity Measurements Off Pt. Sur, California," Oceanographic Society Annual Meeting, Monterey, 1989.

Collins, C. A. and T. A. Rago, "Vertical Structure of Currents on the Axis of Monterey Submarine Canyon in Water 2200m deep," Eastern Pacific Oceanic Conference, Asilomar, 1989.

THESES DIRECTED: C.H. King, LT, USN, "A Comparison of Pegasus and Combined CTD/ADCP Current Profiles off the California Coast," M.S., June 1989.

R.Reece, LT, USN, "Comparison and Analysis of Hydrographic Data from the Pt. Sur Transect of Nov 88," M.S., June 1989.

P. Berryman, LT, USN, "Study of Currents along the Pt. Sur Transect in February 1989," M.S., September 1989.

MARINE OPERATIONS

C. A. Collins, Professor and Chairman of Oceanography
Sponsor: Commander, Naval oceanography Command

OBJECTIVE: To provide administrative and logistical support for shipboard operations necessary for research and instruction.

SUMMARY: The marine operations program supported 75 days at sea in FY89 on the R/V Pt. Sur. An additional 37 days at sea was supported on other research vessels including the USNS DeSteiguer, USNS Bartlett, and the R/V Ricketts. Activities included the Operational Oceanography course (OC/MR 3570) in spring and fall quarters, Ocean Acoustic Tomography course (EC 4930), research along the Pt. Sur transect including current meter moorings and direct current observations and observations in the Greenland Sea.
The marine operations program maintains equipment which is routinely used at sea: CTDs, XBTs, and a shipboard data acquisition system. Salinometers and calibration facilities are also maintained. The program actively interfaces with other local ship users through the Central California Consortium (CENCAL), with other national academic ship users through the University National Ocean Laboratory System (UNOLS), and with Navy research vessels through the Naval Oceanographic Office.

PUBLICATION: Rienecker, M.M. and C.N.K. Mooers, "Mesoscale Eddies, Jets and Fronts off Point Arena, July 1986," Journal Geophys. Res., (C9):12544-12569, 1989.

Rienecker, M.M. and C.N.K. Mooers, "A Summary of the OPTOMA Program's Mesoscale Ocean Prediction Studies in the California Current System," Mesoscale/Synoptic Coherent Structures in Geophysical Turbulence, J. C. J. Nihoul and B. M. Jamart, editors, 519 - 547, 1989.

Itsweire, E. C., T. R. Osborne, and T.P. Stanton, "Horizontal Distribution and Characteristics of Shear Layers in the Seasonal Themocline," J. Phys. Oceanogr 19, 301-320, 1989.

Medwin, H. and N. D. Breitz "Ambient and Transient Bubble Spectral Densities in Quiescent Seas and Under Spilling Breakers," Journal of Geophysical Research, Vol 94, (C9), 12,751-12,759.

Jessen, P.F., S.R. Ramp, and C. Clark, "Hydrographic Data from the Pilot Study of the Coastal Transition Zone (CTZ) Program: 17-26 March, 1987," Naval Postgraduate School Technical Report NPS-68-89-001, 1989.

Jessen, P.F., S. R. Ramp, and C. Clark, "Hydrographic Data from the Coastal Transition Zone Program: 15-28 June 1987," Naval Postgraduate School Technical Report NPS 68-89-004

Carpenter, G. H., "Surface Circulation Associated with the Mindanao and Halmahera Eddies," Naval Postgraduate School Technical Report NPS 68-89-005.

CONFERENCE PRESENTATIONS Ramp, S.R., R. W. Garwood, C. Davis, and R. L. Snow: "Surface Heating and Patchiness in the Coastal Ocean off Central California During a Wind Relaxation Event," Presented at the Inaugural meeting of The Oceanography Society, Monterey, CA, August 1989

Berryman, P., T. Rago and C. Collins, "Velocity Measurements off Pt. Sur, California," Oceanography Society Annual Meeting, Monterey, CA, August 1989.

Rago, T. A. and C. A. Collins, "Measurements of Ocean Currents across the Continental Margin off Pt. Sur, California,from April 1988 to March 1989," Fall National Meeting, American Geophysical Union, San Francisco, CA, December 1989

Robson, A., C. A. Collins, and M. McCann, "Circulation of the California Undercurrent near Monterey," Fall National Meeting, American Geophysical Union, San Francisco, December 1989

Tsai, C. M., P. Jessen, P. C. Chu and C.A. Collins, "Small Scale Structure of the California Current from Combined XBT/ADCPMeasurements," Fall National Meeting, American Geophysical Union, San Francisco, CA, December 1989.

THESES DIRECTED: W.C. Fasciano, LCDR, USN, "Meandering of the Coastal Upwelling Jet Near Cape Mendocino, California: A Comparison Between Laboratory Simulations and Oceanic Observations," M.S., June 1989.

C.H. King, LT, USN, "A Comparison of Pegasus and Combined CTD/ADCP Current Profiles off the California Coast," M.S., 1989.

MARINE OPERATIONS (CONT)

C.H. Carpenter, LCDR, USN, "Surface Circulation Associated with the Mindanao and Halmahera Eddies," M.S., June 1989.

R. Reece, LT, USN, "Comparison and Analysis of Hydrographic Data from the Point Sur Transect, November 1988," M.S., June 1989.

D.L. McKinney, CDR, USN, "Near Real Time VHF Telemetry of Nearshore Oceanographic Data," M.S., June 1989.

J.S. Best, LT, USN, "Correlation of AVHRR Imagery with Sub-Surface Features in the California Current," M.S., June 1989.

F.L. Dagget, LT, USN, "A Study of the Velocity Structure Near a Cold Filament from ADCP and CTD Measurements," September 1989.

P. Berryman, LT, USN, "Study of Currents Along the Pt. Sur Transect in February 1989," M.S, September 1989.

L. Jendro, LCDR, USN, "Investigating Acoustic Fronts Presented by Filaments in Eastern Boundary Currents, M.S, September 1989.

J. Moshovos, LT, Greek Navy, "Comparison of At-Sea Positions Using Mini-Ranger and LORAN C in the Context of Measuring Current Velocity with Shipboard ADCP," M.S., December 1989.

POSTDOCTORAL SUPPORT FOR STUDIES OF THE CALIFORNIA UNDERCURRENT

C. A. Collins, Professor and Chairman of Oceanography
Sponsor: NPS Research Council

OBJECTIVE: To develop a better understanding of the kinematics and dynamics of the California Undercurrent.

SUMMARY: Dr. Newell Garfield joined our faculty as a Postdoctoral Oceanographer in July. He has served as chief scientist on the 25 - 30 September cruise and is contributing significantly to California Undercurrent Studies. He has developed a program for processing multichannel Pegasus data. He is also putting in place a capability to process.

COUPLED ATMOSPHERIC AND OCEANIC BOUNDARY LAYERS

Roland W. Garwood, Jr., Professor of Oceanography
Pecheng Chu, Adjunct Research Professor of Oceanography
Sponsor: Office of Naval Research

OBJECTIVE: To develop a comprehensive model for the analysis and prediction of coupled oceanic and atmospheric boundary layers.

SUMMARY: A new feedback mechanism between the clouds and the oceanic mixed layer has been discovered. It is found that clouds reduce the solar radiation at the ocean surface by scattering and absorption, which cools the ocean surface layer by increasing mixed layer entrainment. The cooling of the ocean mixed layer lowers the evaporation rate, which will diminish the clouds. This is a negative feedback mechanism. On the other hand, precipitation dilutes the surface salinity, stabilizing the upper ocean and reducing mixed layer deepening. The reduction in the mixed layer depth will increase the sea surface temperature by concentrating the net radiation plus heat fluxed downward across the sea surface into a thinner layer. The increase of sea surface temperature augments the surface evaporation, which in turn produces more clouds. This is a positive feedback mechanism.

PUBLICATIONS: Chu, P.C., "Relationship Between Thermally Forced Surface Wind and Sea Surface Temperature Gradient,". Pure & Appl. Geophys., 130, 31-45, 1989.

Chu, P.C., and R.W. Garwood, Jr., "Cloud-Ocean Mixed Layer Feedback: Role of Clouds in Atmospheric Chemistry and Global Climate," Amer. Meteor. Soc., 39-44, 1989.

Chu, P.C., and R.W. Garwood, Jr., "Thermodynamical Feedback Between Cloud and Ocean Mixed Layer," Adv. Atmos. Sci., 7, Springer-Verlag, New York, in press.

Chu, P.C., and R.W. Garwood, Jr., "Effects of Hydrological Cycle on the Air-Ocean Coupled System," Trans. Amer. Geophys. Union, 70, 297.

Chu, P.C., and R.W. Garwood, Jr., "Effects of Vertical Mixing and Entrainment on the Equatorial Air-Sea Couple System," TOSIM, 11, 1989.

Chu, P.C., and R.W. Garwood, Jr., "Hydrological Effects on the Air-Ocean Coupled System," Proceedings, Western Pacific International Meeting and Workshop on TOGA/COARE, in press.

Chu, P.C., R.W. Garwood, Jr., and P. Muller, "Unstable and Damped Modes in Coupled Ocean Mixed Layer and Cloud Models," J. Marine Systems, 1, in press, 1989.

Garwood, R.W., Jr., P.C. Chu, P. Muller, and N. Schneider, "Equatorial Entrainment: The Diurnal Cycle," Proceedings, Western Pacific International Meeting and Workshop on TOGA/COARE, in press.

Garwood, R.W., Jr., P.C. Chu, P. Muller, and N. Schneider, "Modeling the Equatorial Entrainment Zone," Submitted to J. Geophys. Res.

CONFERENCE PRESENTATION: Chu, P.C., and R.W. Garwood, Jr., "Cloud-Ocean Mixed Layer Feedback," Amer. Meteor. Soc. Meeting, Anaheim, CA, 30 January - 3 February, 1989.

Chu, P.C., and R.W. Garwood, Jr., "Hydrological Effects on the Air-Ocean Coupled System," International TOGA/COARE Conference, Noumea, New Caledonia, 24-30 May 1989.

Garwood, R.W., Jr., P.C. Chu, P. Muller, and Schneider, "Equatorial Entrainment: The Diurnal Cycle," International TOGA/COARE Conference, Noumea, New Caledonia, 24-30 May 1989.

Chu, P.C., R. W. Garwood, Jr., and P. Muller, "Unstable and Damped Modes in Coupled Cloud and Ocean Mixed Layer System," The 21th International Liege Colloquium on Ocean Hydrodynamics, Liege, Belgium, 8-12 May 1989.

Chu, P.C., and R.W. Garwood, Jr., "Importance of Cloud-oceanic Mixed Layer Feedback in Ocean Prediction," Air Sea Conference, sponsored by NOARL, Monterey, 31 August - 1 September 1989.

Chu, P.C. and R.W. Garwood, Jr., "Effects of Vertical Mixing and Entrainment on the Equatorial Air Sea Coupled System," The Oceanography Inaugural Meeting, Monterey, CA., August 27, 1989.

NPS DRIFTING AMBIENT NOISE BUOY PROGRAM

Jeffrey A. Nystuen, Assistant Professor of Oceanography
Sponsor: NOARL

OBJECTIVE: To assess the feasibility of monitoring and predicting geophysical quantities (wind stress, precipitation rate, ambient bubble populations) using ambient underwater sound measurements made from remote drifting buoys. This research includes drifters, laboratory and theoretical work.

SUMMARY: During 1989 significant progress was made in laboratory experiments designed to explore the nature of sound generated by individual raindrops. In particular a study was made of the sound generated by large raindrops in the raindrop tower. These data were summarized and presented as part of the invited talk that was presented at the Acoustical Society of America Spring Meeting. That talk also summarized evidence for successfully monitoring precipitation at sea using underwater sound.

A second project, undertaken by a student, identified the character of the sound generated by the impacts and bubbles of small raindrops at normal and oblique incidence. With these data it appears possible to explain the change that occurs in the underwater sound field produced by light rain in the presence of wind (previously unexplained).

The drifter component of this project has proceeded more slowly. A drifter design was approved and the components were ordered for two ambient noise drifters with ARGOS communication capabilities. Two contractors were used, one for the electronics and one to construct the buoys. The buoys have been delivered, unfortunately the electronic components are not working properly. The buoys have not been deployed. Considerable effort has gone into determining if we can produce these buoys locally. Unfortunately this effort has been delayed by the untimely death of a key staff member. Part of the drifter project is to compare the acoustic data with simultaneously obtained SSM/I satellite data. The logistical link for obtaining SSM/I data through FNOC has been established and will be operational when the drifters are deployed.

PUBLICATIONS: Nystuen, J.A. and D.M. Farmer, "Precipitation in the Canadian Atlantic Storms Program: Measurements of the Acoustic Signature," Atmosphere-Ocean 27, 237-257 1989.

Medwin, H., A. Kurgan and J.A. Nystuen, "Impact and Bubble Sound from Raindrops at Normal and Oblique Incidence," In preparation for the J. Acoust. Soc. Am., Dec 1989.

CONFERENCE PRESENTATION: J.A. Nystuen, "Monitoring Oceanic Precipitation using Ambient Sound - An Assessment," Acoustical Society of America, 1989 Spring Meeting, Syracuse, NY.

THESIS DIRECTED: Armagan Kurgan, "Underwater Sound Radiated by Impacts and Bubbles Created by Raindrops," co-advisor H. Medwin, December 1989.

INFLUENCE OF RAIN AT THE AIR/SEA INTERFACE

Jeffrey A. Nystuen, Assistant Professor of Oceanography
Sponsor: ONR

OBJECTIVE: To explain the formation of a thin turbulent surface layer by rainfall and to predict the influence of that layer on the attenuation of surface gravity waves on the ocean.

SUMMARY: This is a new project. An analytical theory explaining the attenuation of surface gravity waves due to a thin rain-induced turbulent layer has been developed. Experimental evidence for the formation of such a mixed layer has been examined and incorporated into the theory. This theory has been presented at the AGU Fall Meeting and submitted to the J. Geophys. Res.

Dr. David Shonting, NUSC, R.I. visited to discuss this problem. He is attempting to collect field data to verify this theory.

Theoretical work modeling the formation of this layer has been started using two separate models, one from Harlow, LANL and one from Garwood, NPS. A graduate student has commenced thesis work on this aspect of the problem.

THE COASTAL TRANSITION ZONE PROGRAM

Steven R. Ramp, Assistant Professor of Oceanography
Paul F. Jessen, Oceanographer
Sponsor: Office of Naval Research

OBJECTIVE: The objective of the CTZ program is to enhance our understanding of the kinematics and dynamics of the cold upwelling filaments which are often observed in the satellite AVHRR and CZCS imagery of the central California coastal waters, and to assess the impact of these features on the across-shelf transport and the biological productivity of the region.

SUMMARY: The emphasis for 1989 was on analysis and publication of the field data collected during 1987 and 1988 as part of the CTZ large scale mapping group. The 1987 surveys provided evidence that the occurrence of the cold filaments is seasonal, with strong features first appearing in late spring. These four surveys also provided evidence that a continuous, meandering equatorward jet could play an important role in filament formation. The smaller 1988 surveys did not observe a strong, organized onshore return flow, but the T-S properties do provide evidence that lower salinity waters are advected into the region from the north by the strong equatorward jet. The maximum offshore velocities lie along the T-S gradients between the cold, salty upwelled water and the warmer, fresher oceanic water, rather than along the core of the cold filament itself. The region of highest nutrients and biological activity coincided with the cold water, which does move offshore, but does so much more slowly than the maximum observed velocities in the jet. One student thesis (Jendro, cited below) used CTZ cruise data to examine acoustic fronts near the filaments and their effect on acoustic propagation and naval tactics. This is the only applied naval research that I am aware of from the entire program. I have also used data and results from the program in my OC3230 and OC/MR 3570 courses.

PUBLICATIONS: Ramp, S. R., R. W. Garwood, C. Davis, and R. L. Snow: "Surface Heating and Patchiness in the Coastal Ocean off Central California During a Wind Relaxation Event."

Washbein, P. M. Kosro, S. Ramp, T. Stanton, L. Washburn, "T-S Characteristics of the Coastal Transition Zone, 1988," 1989.

Jessen, P. F., S. R. Ramp, and C. Clark, "Hydrographic Data from the Pilot Study of the Coastal Transition Zone (CTZ) Program: 17 - 26 March, 1987," Naval Postgraduate School Technical Report NPS-68-89-001.

Jessen, P. F., S. R. Ramp, and C. Clark, "Hydrographic Data from the Coastal Transition Zone Program: 15 - 28 June 1987," Naval Postgraduate School Technical Report, 1989, NPS-68-89-004.

Jessen, P. F., and S. R. Ramp, "Hydrographic Data from the Coastal Transition Zone Program: 5 - 19 July 1988," Naval Postgraduate School Technical Report. (In preparation).

CONFERENCE PRESENTATIONS: Ramp, S. R., R. W. Garwood, C. Davis, and R. L. Snow, "Surface Heating and Patchiness in the Coastal Ocean off Central California During a Wind Relaxation Event," Presented at the Inaugural meeting of The Oceanography Society, Monterey, CA, August 1989.

Ramp, S. R. "Comparison of CTD Temperature and Continuous In-Situ Florescence in the Upper Water Column During CTZ Mapping Cruises 3 and 4, July 1988," CTZ PI Meeting, Corvallis, OR, July 1989.

THESES DIRECTED: W.C. Fasciano, "Meandering of the Coastal Upwelling Jet Near Cape Mendocino, California: A Comparison Between Laboratory Simulations and Oceanic Observations," M.S., June 1989.

J.S. Best, LT, USN, "Correlation of AVHRR Imagery with Sub-Surface Features in the California Current," M.S., June 1989.

F.L. Daggett, LT, USN, "A Study of the Velocity Structure Near a Cold Filament from ADCP and CTD Measurements," M.S., September 1989.

L. Jendro, LCRD, USN, "Investigating Acoustic Fronts Presented by Filaments in Eastern Boundary Currents," M.S., September 1989.

THE POINT SUR TRANSECT (POST) PROGRAM

Steven R. Ramp, Assistant Professor of Oceanography
Dale Pillsbury, College of Oceanography, Oregon State University,
Paul Jessen, Todd Anderson, and Marla Stone
Sponsor: Naval Postgraduate School Direct Research Funding.

OBJECTIVE: To resolve the physical and biological variability of the California Current System off Point Sur, CA at seasonal and longer time scales, using both shipboard and moored measurements maintained for a period of at least 5 years. Two problems of particular interest are the dynamics and kinematics of the California Undercurrent and the resolution of El Nino/Southern Oscillation (ENSO) events.

SUMMARY: The optimal positions for the moorings were determined through careful study of the hydrographic data obtained semi-annually since fall 1986. Two subsurface pilot moorings were successfully deployed and recovered from May to August and August to December 1989 on the 800 m isobath off Point Sur. Complete data sets were obtained from all the current meters at 100, 350, and 500 m depth, for a total of seven months of continuous data so far. The complete array consists of and upward looking moored ADCP at the shelf break, plus two conventional subsurface moorings at the 800 and 1800 m isobaths along 36° 20'N off Point Sur, spanning the undercurrent. A fourth mooring at 1100 m off Point Piedras Blancas will be used to examine the alongshore variability, and a meteorological buoy near 36° 20'N, 122° 10.5' W will be used to examine the local forcing. All the subsurface moorings are now in place. The ADCP and the met buoy will be added to the moorings already deployed in February 1990. The hydrographic component of the program is continuing. We are cooperating with other investigators working in the area (Prof. C. Collins, NPS, hydrography and PEGASUS sections; R. Barber, F. Chavez, C. Pilskaln, MBARI, nutrient and other current measurements; P. Niiler, Scripps, upcoming California Current ARI).

THE PHYSICAL OCEANOGRAPHY OBSERVATION LABORATORY

Steven R. Ramp, Assistant Professor of Oceanography
Curtis A. Collins, Professor of Oceonography
R.W. Garwood, Professor of Oceanography
Sponsor: Naval Postgraduate School Direct Research Funding

OBJECTIVE: To acquire and maintain the equipment, personnel, and expertise necessary to support a small buoy group at the Naval Postgraduate School capable of successfully calibrating, deploying and recovering moored instrumentation in the ocean.

SUMMARY: Two individuals were hired this year bringing the group to three. Mr. Todd Anderson from Scripps will act as the POOL manager. He will interface with the faculty users of the group and handle long range planning to make sure that all needs can be met. He will also be closely involved with surface met buoy and moored ADCP instrumentation. Ms. Marla Stone was hired from Moss Landing Marine Lab. She will be a current meter and acoustic release technician, and take the lead in mooring deployment and recovery operations at sea. She continues to work closely with Dr. Dale Pillsbury and Mr. Bob Still of Oregon State University (OSU) to acquire these skills. Mr. Paul Jessen is still involved in time series data processing and software development. We continued to work closely with the OSU buoy group during 1989, to the benefit of all. A pilot mooring off Point Sur was successfully deployed and recovered from May to August 1989. The mooring was successfully recovered and redeployed during December 1989, along with two additional moorings at the 1800 m isobath off Point Sur and at the 1100 m isobath off Point Piedras Blancas. Procurement actions are pending to increase our instrumentation inventory from 17 to 24 Aanderaa RCM8 current meters, 10 to 18 EG&G BACS 8242 acoustic releases, and the flotation, wire, hardware, etc. necessary to do the work.

There are very few institutions around the country that have the ability to do this kind of work. We are well on our way to becoming one of them.

THESIS DIRECTED: D.L. McKinney, CDR, UNS, "Near Real Time VHF Telemetry of Near Shore Oceanographic Data," M.S., June 1989.

MIXING IN THE UPPER OCEAN DUE TO FINE SCALE SHEAR

T.P. Stanton, Adjunct Research Professor of Oceanography
E.B. Thornton, Professor of Oceanography
Sponsor: Office of Naval Research Physical Oceanography.

OBJECTIVE: The objectives of this research were to develop doppler profiling systems capable of measuring 3 component profiles from 10m down to cm scales, and to deploy them in two field programs involved with upper ocean turbulence. A study of turbulence in the velocity field just below deep water surface gravity waves was executed as a component of the SAXON experiment, which was staged from Chesapeake Lighthouse in October 1989. A second field deployment measured sub-ice boundary layer turbulence and thermal microstructure at the CEAREX "O" camp during March 1988, northwest of Spitzbergen.

SUMMARY: Two different acoustic velocity measuring systems are being developed. 1.) The first is a bistatic geometry, coherently sampled, doppler profiler operating at 300hz, which measures 3 component velocities every 10cm from scatterers in an 0(1 liter) volume along a narrow transmitter beam. Phase coherent sampling of the doppler shift frequencies has provided high temporal accuracy in good scattering conditions. 2.) A 5 MHz doppler velocimeter and temperature/ conductivity microstructure system is being developed to resolve sub-cm scale velocity structure in front of a loose tethered profiling instrument. A computer controlled servo winch to handle the kevlar / fiber optic tether line has also been implemented to allow automated profile time series to be measured. The combined 3 component velocity and thermal microstructure measurement allows small scale momentum and scale fluxes to be estimated. Measurements of finescale velocity structure immediately below a wind driven surface gravity wave field have been successfully made with a non-invasive acoustic doppler instrument which resolves three component velocity estimates every 10cm from a single small sample volume, allowing vertical Reynolds stress components to be directly estimated and compared with atmospheric forcing. The same system and similar processing methods have been used to measure a sub-ice boundary layer under a wide range of mean flow and turbulent conditions.

PUBLICATIONS: E.C. Itsweire, T.R. Osborne, and T.P. Stanton, "Horizontal Distribution and Characteristics of Shear Layers in the Seasonal Thermocline," J. Phys. Oceanogr., 19, pp. 301-320, 1989.

T.P. Stanton, "Bistatic Geometry Coherent Acoustic Doppler Profiler for Oceanic Turbulence and Wave Measurements," In Preparation.

T.P. Stanton, "Estimation of Reynolds Stresses Using a Bistatic Coherent Doppler Profiler," Poster T3.OA,04,42, 1989.

T.P. Stanton, "Momentum Fluxes in a Wind Driven Surface Gravity Wave Field," Trans. Am. Geophys. Union, 70, 1166, 1989.

CONFERENCE PRESENTATIONS:T.P. Stanton, "Estimation of Reynolds Stresses Using a Bistatic Coherent Doppler Profiler," TOS Inaugural Meeting, Monterey, CA, August 1989.

T.P. Stanton, "Momentum Fluxes in a Wind Driven Surface Gravity Wave Field," AGU Fall Meeting, San Francisco, December 1989.

THESIS DIRECTED: M. Abreau, "Kinematics Under Stress Wind Waves," M.S., September 1989.

MIXING ASSOCIATED WITH UPWELLING JETS IN THE COASTAL TRANSITION ZONE

T.P. Stanton, Adjunct Research Professor of Oceanography
E.B. Thornton, Professor of Oceanography
Sponsor: Office of Naval Research Physical Oceanography.

OBJECTIVE: The primary objective of these studies is to understand whether there are enhanced mixing rates due to double diffusive conditions, and high horizontal and vertical current shear near strong offshore jets. As these features also appear to change rapidly in response to wind forcing, the sudden disappearance of cool surface features seen in AVHRR satellite imagery is being studied in terms of the estimated mixing rates and atmospheric fluxes.

SUMMARY: Five cross-jet transects of velocity, CTD, and conductivity microstructure data, gathered during the OPTOMA21 cruise in July 1986, are being analyzed to identify mixing patches and their relationship to the jet flow axis and temperature and salinity fronts, as the jet evolves offshore. The high horizontal resolution towyo and ADCP transects have allowed vertical shear regions and thermohaline intrusions to be identified, and the conductivity microstructure measurements provide estimates of mixing activity.

Three of the six sequential hydrographic mappings of the "CTZ domain" off Point Arena are being used with AVHRR imagery sequences of the same domain to study the changes in both the surface and subsurface structure of the jet following a sudden drop in upwelling favorable winds in late July 1988. Regional surface fluxes are being estimated from 3 channels of the AVHRR and modelled wind data to allow surface heating to be calculated following the relaxation event, to test the hypothesis that surface warming is sufficient to irradiate the filament surface signature.

RESEARCH NARRATIVE

Albert J. Semtner, Professor of Oceanography

SUMMARY: The following information is provided to give an overview of my research in 1989. That research deals with the highly Navy relevant topic of ocean modeling but is carried out at little or no cost to the Navy. The work is funded by the National Science Foundation and the Battelle Pacific Northwest Laboratories, with computer time provided by the National Center for Atmospheric Research. The work has been the subject of several publications and presentations and many ongoing collaborations. It provides the material for masters-level research (two in progress) and doctoral-level research (one just completed). Details are given below.

RESEARCH INTERESTS: Development of physically realistic global ocean circulation models. Algorithm design to maximize vectorization and parallel processing performance of ocean models on emerging supercomputer technologies. Simulation and understanding of the large scale ocean circulation and the acoustic properties of the global ocean.Simulation and understanding of the role of mesoscale eddies in the ocean general circulation.

RESEARCH SUPPORT AT NPS DURING 1989: Completed a study of the interannual variability of Arctic ice-ocean circulation under a one-year grant from NSF's Office of Polar Programs.
Supported by NSF's Climate Dynamics Program for a two-year study underway of the interannual variability of the Tropical Pacific Ocean.
Also funded by NSF's Physical Oceanography Program for 30 months to develop and use a global eddy-resolving thermodynamic ocean model for the 1990's. Supported by Battelle Pacific Northwest Laboratories to analyze results of a global eddy-resolving model, including the acoustic signal of mesoscale eddies and seasonal fluctuations across very large distances. Used a total of 700 CPU hours of computer resources on the Cray X-MP system at the National Center for Atmospheric Research (NCAR) for NSF-supported research.

RESEARCH ACTIVITIES AT NPS IN 1989: Multidecade prognostic integrations of a global, half-degree, 20 level ocean model with resolved eddies, realistic continental outlines, observed bathymetry, and Hellerman monthly wind forcing. The model is optimized for the Cray Y-MP and anticipated future computers and runs at a sustained speed of 1125 megaflops on the CRAY Y-MP/8. Twenty-seven years of simulation are complete as of January 1990. Collaborations and/or interactions on various aspects of global ocean modeling with: Dr. Robert Chervin, National Center for Atmospheric Research (global ocean simulations on supercomputers); Dr. Walter Munk, Scripps Institution of Oceanography (acoustic monitoring of global ocean warming); Dr. John Spiesberger, Woods Hole Oceanographic Institution (North Pacific acoustic tomography); Dr. Ching-Sang Chu, Naval Postgraduate School (acoustics of the global ocean); Dr. Sylvia Garzoli, Columbia University (dynamics of western boundary currents); Dr. Don Altman, Institute for Naval Oceanography (predictability in global versus regional ocean models); Dr. Stuart Godfrey, CSIRO Australia (dynamics of the South Indian Ocean and the Tasman Sea); Dr. James Alexander, University of Maryland (effect of sea-height variations on satellite measurements of the geoid); Drs. Larry Gates, Livermore Labs, and Dave Randall, Colorado State University (ocean modeling in climate research); Dr. Peter Killworth (ocean model development);Dr. Dave Halpern, California Institute of Technology (equatorial ocean response to variable wind forcing); and Dr. Jorge Sarmiento, Princeton University (modeling euphoric-zone biology in the global ocean).

CONFERENCE PRESENTATIONS: Seminar presentations at other sites during workshops and/or collaborations: National Center for Atmospheric Research, Princeton University, Fleet Numerical Oceanography Center, Lawrence Livermore Laboratories, the Inaugural Meeting of the Oceanography Society, and the Aspen Global Change Institute.

PUBLICATIONS: Chervin, R.M., and A.J. Semtner, "Development of an Ocean Modeling System for Supercomputers of the 1990's," Proc. NATO Advanced Research Workshop on Climate-Ocean Interactions, Dordrecht, Holland, in press.

Semtner, A.J., and R.M. Chervin, "Breakthroughs in Ocean and Climate Modeling Made Possible by Supercomputers of Today and Tomorrow," Proc. Supercomputing '88 Conference, IEEE Publications, Washington D.C., pp 230-239.

A.J. Semtner, "Evironmental Effects on Acoustic Measures of Global Ocean Warming," J. Geophys. Res., Submitted.

RESEARCH NARRATIVE (CONT)

Fleming, G.H., and A.J. Semtner, "A Numerical Study of Interannual Ocean Forcing of Arctic ice," J. Geophys. Res., Submitted.

THESIS DIRECTED: G. Fleming, LCDR, "Interannual Variability of Arctic Sea Ice and Ocean Circulation," PH. D., September 1989.

EDDY INTERACTION WITH TOPOGRAPHY AND COASTAL JETS IN AN EASTERN BOUNDARY CURRENT

D.C. Smith IV, Assistant Professor of Oceanography
Sponsor: Office of Naval Research

OBJECTIVE: To examine the interaction an ocean eddy with an adjacent eastern boundary current.

SUMMARY: The interaction of eddy with a sheared open ocean zonal jet has been examined in a series of flat bottom numerical experiments. Results indicate that the motion of eddies such as Gulf Stream rings can be strongly influenced when in close proximity to the Gulf Stream. These results have significant implications for ocean forecast model development.

PUBLICATIONS: D.C. Smith IV and G.P. Davis "Numerical Study of Eddy Interaction with an Ocean Front," Journal of Physical Oceanography 19, 975-986, 1989.

Smith D.C. IV, and A.A. Bird, "Factors Influencing Asymmetry and Self Advection in Ocean Eddies," Synoptic/Mesoscale Coherent Vortices in Geophysical Turbulence Elsevier, 1989.

CONFERENCE PRESENTATIONS: Smith D.C. IV. and A.A. Bird, "A Numerical Study of Eddy Interaction with an Ocean Jet Spring Meeting," American Geophysical Union, Baltimore M.D. May 1989.

Smith D.C. IV and A.A. Bird, "A Numerical Study of Circulation in Monterey Bay," Inaugural Meeting of the Oceanography Society, Monterey, August 1989.

Bird A.A. and D.C. Smith IV, "Eddy Jet Interactions as Revealed by Animation Geophysical Union," San Francisco Dec 1989.

MESOSCALE EDDY/MARGINAL ICE ZONE INTERACTION MODELING

D.C. Smith IV, Assistant Professor, Department of Oceanography
Sponsor: Office of Naval Research

OBJECTIVE: To examine the various mesoscale ocean eddy processes which occur in Marginal Ice Zone regions

SUMMARY: Satellite images of the ice edge in marginal ice zone regions of the oceans indicate a variety of mesoscale ocean motions. To aid the interpretation of Satellite imagery eddy processes are studied using air ocean numerical model with coupled ice cover. The results indicate how ocean eddies interact with the ice edge and are influenced by wind forcing.

PUBLICATIONS: Smith D.C. IV, A.A. Bird and W.P. Budgell "A Numerical Study of Mesoscale Eddy Interaction with a Marginal Ice Zone," Journal of Geophysical Research 93, 12461-12473.

THESES DIRECTED: R.P. Lumpkin, "A Numerical Study of Eddy Interaction with a Marginal Ice Zone Ocean," M.S., May 1989.

D.W. McShare, "Numerical Study of circulation in Fram Strait," M.S., August 1989.

CONFERENCE PRESENTATIONS: Smith D.C. IV and G.P. Davis "Numerical Study of Eddy Interaction with Air Ocean Jet," Journal of Physical Oceanography 19, 975-986, 1989.

Smith D.C. IV and A.A. Bird "Factors Influencing Asymmetry and Self Advection in Ocean Eddies," in synoptic/Mesoscale Coherent Vortices in Geophysical Turbulence Elsevier, Nihoul ed. External Presentations, 1989.

Smith D.C IV and A.A. Bird, "A Numerical Study of Eddy Interaction with an Ocean Jet," Spring Meeting, American Geophysical Union, Baltimore, MD., May 1989.

Smith D.C. IV and A.A. Bird, "A Numerical Study of circulation in Monterey Bay," The Inaugural meeting of the Oceanography Society Monterey, Aug 1989.

Bird A.A. and D.C. Smith IV., "Eddy - Jet Interactions as Revealed by Animation,"Fall meeting, American Geophysical Union, San Francisco, CA, Dec. 1989.

Smith D.C. IC and A.A. Bird "Dipole Formation Mechanisms in the Marginal Ice Zones," Fall meeting, American Geophysical Union, San Francisco, CA, Dec 1989.

NEARSHORE WAVE PROCESSES

E.B. Thornton, Professor of Oceanography
C.S Wu, Adjunct Research Professor of Oceanography
Sponsor: Office of Naval Research

OBJECTIVE: Predict the wave-induced three-dimensional velocity field over arbitrary bathymetry in the nearshore.

SUMMARY: Velocities at three levels, surface elevations, and wind velocities were measured from a mobile sled during the one month SUPERDUCK experiment. The sled was positioned at various locations across the barred beach to obtain three-dimensional wave-induced kinematics of the surf zone. Dynamical models have been developed and compared with the data for mean (averaged over depth and time) longshore currents, rip currents, the vertical structure of longshore and cross-shore currents, and shear wave kinematics and induced mixing. It is demonstrated that mixing of the perturbation velocity momentum of the shear waves must occur for their existence, and that this mixing at least partially explains the mixing required for predicting the cross-share velocity profiles of longshore currents.

PUBLICATIONS: Whitford, D. J. and E. B. Thornton "Comparison of Wind and Wave Forcing of Longshore Currents," J. of Coastal Engineering, Forthcoming.

Dodd, N. and E. B. Thornton, "Growth and Energetics of Shear Waves in the Nearshore," J. of Geophysical Research, Forthcoming

CONFERENCE PRESENTATIONS: Dodd, N. and J. Oltman-Shay, "Shear Waves in the Nearshore: A Comparison of Theory and Observation," American Geophysical Union, San Francisco, CA, 5-9 Dec 1989.

Thornton, E.B. and N. Dodd, "Mixing in the Nearshore by Shear Waves," American Geophysical Union, San Francisco, CA 5-9 Dec 1989.

Scott, K. and E. B. Thornton, "Mean Cross-Shore and Longshore Currents on a Barred Beach," American Geophysical Union, San Francisco, CA, 5-9 Dec 1989.

Wu, C. S. and E.B. Thornton, "Monochromatic and Random Wave Modeling of Rip Currents on a Barred Beach," American Geophysical Union, San Francisco, CA 5-9 Dec 1989.

Thornton, E.B., "Status and Future Research Direction of Nearshore Currents," Conference on Research in the Nearshore, sponsored by ONR and NSF, St. Petersburg, Florida, 24-27 April 1989.

INTERFEROMETRIC SAR IMAGING OF OCEAN CURRENTS

E.B. Thornton, Professor of Oceanography
Sponsor: Office of Naval Research

OBJECTIVE: The objectives of this research are to perform ground truth experiments, develop the Interferometric SAR image processing techniques and develop a theoretical basis for inferring ocean surface currents and directional wave spectra.

SUMMARY: Interferometric Synthetic Aperture Radar (INSAR) is a relatively new method of imaging ocean surface velocity fields. The basic technique consists of aligning two physically separated antennas located along the radar platform flight path. The received signals are processed separately into two complex maps. These two maps are combined interferometrically into a single image. Unlike conventional SAR, which provides a map of covariance of complex reflectivity, the phase of each pixel in the resulting interferogram is directly proportional to the velocity component of the ocean surface in the viewing direction.

A ground truth experiment was performed September 8, 1989 in the nearshore region of Monterey Bay. Remote imagery of the ocean surface was carried out by INSAR mounted on JPL/NASA DC-8 aircraft. The area imaged by INSAR was about 11km X 11km, centered on a four pressure-sensor-array located offshore at 16m water depth, which provided directional spectra at the time of INSAR measurements. The aircraft flight pattern consisted of four orthogonal legs providing large coverage with high resolution (11m x 12m) of ocean surface variability. In addition, extensive simultaneous ground-based measurements were performed, including the above mentioned shallow water array, deep water pitch and roll buoy, Lagrangian surface drifters deployed from a ship following the mean surface current, and wind velocity. The sea and weather conditions were ideal for INSAR imagery of dominant wave systems. The wind velocity was about 1 -2 m/s, the mean near surface currents as inferred from 10 Lagrangian drifters were about 25 cm/s.

Two dominant wave systems are clearly seen in the INSAR image. Refraction of a long-fetched background swell system propagating from the southeast with a wavelength of about 400m (16s period) is observed. A second wave system with the wavelength of about 130m (9s period) was propagating from the northwest. The directional spectrum of the surface elevation obtained by simultaneous ground-based measurements exhibits two distinct peaks at the frequencies corresponding to the wave systems observed in the image. The velocity field 2-D wavenumber spectrum was calculated from the INSAR images and the correspondingly adjusted directional frequency spectrum estimated from the shallow water array data compare well.

DEPARTMENT OF OPERATIONS RESEARCH

DEPARTMENT OF OPERATIONS RESEARCH

The research program in the department of Operations Research seeks to advance the field's state of knowledge in areas important to the Department of Navy, Department of Defense, and military planning. The study of operational problems often involves the structuring and integration of a number of interdisciplinary components, and the results is a very rich collection of applications. In many instances the methodologies developed are of general interest extending well beyond the problems that spawned them. In these cases our researchers will generalize their work and seek broader recognition.

This report contains the research summaries submitted by the department faculty for the calendar year 1989. For the convenience of the reader, a "summary of the summaries" appears in this cover statement. It is organized according to academic content, and the descriptions are largely in terms of the applied problems treated. Authors are identified in parentheses, and upon occasion, names of collaborators outside of our department are also identified. The specific areas currently represented are large scale optimization, stochastic models and simulation, statistics and data analysis, operations studies, combat modelling and war gaming. Sponsors are not immediately identified, but can be located in the individual summaries.

Tangible output appears in the form of student theses, reports to sponsors, Naval Postgraduate School technical reports, conference presentations, and refereed articles in the open professional literature. The research summaries of department faculty whose efforts involved projects sponsored outside of the department are reported elsewhere. Also, research involving security classified matters are not reported here.

LARGE SCALE OPTIMIZATION

A broad spectrum of mixed integer programming applications have been treated as a general class. The identification and exploitation of special problem structure is a continuing theme (Bradley, Brown, Wood). Specialized decomposition and relaxation methods have been developed for the sub problems. Also some network basis factorizations have been successfully implemented. Applications include the schedules of fleet combatants; optimization of purchase, storage, and transmission contracts; solving multi-commodity flow problems; capital allocation and project selection.

The performance of integrated air defense networks is studied under a framework for optimizing stochastic networks (Bailey). Approximation techniques are developed (Lawphonpanich, Rosenthal) to provide rapidly available solutions for the logistics component of time sensitive or crisis development decisions. A traffic assignment problem has been successfully treated with reduced computation time using a line search step (Lawphongpanich) added to generalized linear programming.

The design and operation of various anti satellite battle management strategies are being treated using optimization (Rosenthal, Eagle).

STOCHASTIC MODELING AND SIMULATION

The performance of the Data Defense Networks as it is affected by use policy parameters has been modeled and studied (Gaver, Jacobs, Purdue). Problems relating to human reliability and linear time inference in queuing settings, have been treated (Gaver, Jacobs).

Development of reliability growth assessment techniques continues (Woods). Damage aggregation models for multiple weapon hits have been developed and used to evaluate empirical rules that supply assessment measures (Esary). Digital transmission errors have been modeled stochastically, and studied (Kang). Major caliber ammunition failure modes are being assessed to determine component reliability requirements (Bailey, Kang, Washburn, Sovereign, Lindsay).

Simulations are being used to examine the influence of model parameters on the demand distributions, (McMasters) in support of the management of repairable items at an inventory control point. The use of expert systems at stock points is also considered.

Feasibility studies are being made to study the civilianization of selected Marine Corps jobs (Milch). Work on Navy officer corps career structure analysis continues (Milch).

STATISTICS AND DATA ANALYSIS

Study of the sources of systematic error in the calibration of three dimensional underwater tracking ranges is continuing (Read). Development has begun on non parametric statistical methods to establish and update optimal maintenance policies (Whitaker). Estimation methods for spatial variability of geographic data are being compared (Johnson).

Statistical support for the tri-service oil analysis program is continuing (Larson, Jayachandran). Many of the recommendations have been made operational. The building of an officer attrition rate generator for USMC manpower planning models is ready for implementation, (Read). It features the integration of an empirical Bayes estimation methods with a cell aggregation scheme.

OPERATIONS STUDIES

Computational methods are being developed for cumulative search and evasion games (Washburn, Eagle). Studies continue to establish the relative capabilities of search and detection models (Forrest, Eagle). Models have been developed to help estimate underwater target localization times (Forrest, Eagle). Work continues on software development in support of air-to-ground munitions provisioning (Brown, Washburn). Investigation into the properties of speech verification systems continue (Poock).

WARGAMING AND COMBAT ANALYSIS

Work continue towards finding a credible means for accessing the information sources and communication levels important to battle force commanders (Sovereign, Thackery, Jones, Sternberg). Data, predictive models, and planning factors have been developed to assist battle force commanders to include logistics in their decision making (Schrady).

Extensions to a theory of combat (Hughes) have been made toward the goal of focusing on inter-relationships between force, maneuver, and suppression as an alternative to the traditional use of attrition. The implementation of the generalized value system in Army models is continuing (Parry). A sequence of experiments is being designed to develop linkages between combat model parameters and selected human factors (Parry).

RELIABILITY AND QUALITY ASSURANCE OF MAJOR CALIBER AMMUNITION

M.P. Bailey, Assistant Professor of Operations Research
M. Bartroli, Adjunct Professor of Operations Research
K. Kang, Adjunct Professor of Operations Research
A. Washburn, Professor of Operations Research
M. Sovereign, Professor of Operations Research
G. Lindsay, Associate Professor of Operations Research
Sponsor: Naval Weapons Service Center, Crane, IN

OBJECTIVE: Investigate the reliability requirements of components of major caliber ammunition.

SUMMARY: The relationship of the failure modes of major caliber ammunition components, gun components, and weapons guidance is explored. Each failure mode causes a different delay to the gunfire system, thus the importance of each failure mode must be determined. The goal is to determine the required level of reliability for each component to ensure a specified probability of mission success. Work on this project has continued through FY90.

LARGE SCALE OPTIMIZATION

M.P. Bailey, Assistant Professor of Operations Research
Sponsor: NPS Research Council

OBJECTIVE: Investigate the structural properties of combinatorial optimization algorithms, and to exploit theses properties to analyze the stochastic behavior of these algorithms when element weights are random variables.

SUMMARY: A large class of combinatorial optimization problems are characterized as the search for the optimal substructure in a complex structure such as a network. Findings the shortest path, the maximum weight spanning tree, or the critical path in a PERT network are examples. When the element weights, e.g. arc lengths, are random variables, the execution of the solution algorithms is a sample path of a stochastic process. Thus, we are interested in the joint distribution of the objective function value and the optimal structure. Results indicate extreme results which are somewhat counter intuitive.

PUBLICATIONS: M.P. Bailey, "Constant Access Systems: A General Framework for Greedy Optimization on Stochastic Networks," NPS-55-89-13.

M.P. Bailey, "Measuring Performance of Integrated Air Defense Networks using Stochastic Networks," (submitted).

CONFERENCE PRESENTATIONS: M.P. Bailey, "Constant Access Systems," Nicholson Prize Award Technical Session," CORS/TIMS/ORSA Joint National Meeting, Vancouver, B.C., Canada, May 1989.

THESES DIRECTED: Tim Gannon, CAPT., USA, "The Dual Decomposition Method and its Application to an Interdicted Network," M.S., March 1989.

B.K. Choi, MAJ, Korean Army, "Why Stochastic Analysis of Logistics Networks is Important," M.S., June 1989.

S.V. Johnson, MAJ, Swedish Army, "interpretation of Enemy Ground Communications Using Constraint Propagation," M.S., September 1989.

LARGE-SCALE OPTIMIZATION

G.H. Bradley - Professor of Operations Research
G.G. Brown - Professor of Operations Research
R.K. Wood - Assoc. Prof. of Operations Research
Sponsor: Office of Naval Research

OBJECTIVE: Develop theory and algorithms for solution of large-scale optimization models (continuing project).

SUMMARY: A continuing research effort emphasizing exploitation of special problem structure. Decomposition and relaxation methods have been developed and applied in concert with specialized algorithms to solve the subproblems produced. Additionally, pure and generalized network basis factorizations have been successfully implemented in the framework of a primal-dual simplex algorithm. The main impetus of this work is provided by large mixed-integer models arising in contexts ranging from weapons systems management to manpower planning. A mathematical programming modeling system to allow direct execution of optimization models is under development. Each component of this system is thoroughly tested on real-life problems provided by other researchers, government agencies and commercial sources. A new research effort is directed at designing and prototyping a computer-based system to support researchers who are developing optimization models and algorithms.

PUBLICATIONS: G.G. Brown, C.E. Goodman and R.K. Wood, "Annual Scheduling of Atlantic Fleet Naval Combatants," Operations Research, forthcoming.

G.H. Bradley, "Mathematical Programming Modeling Project - Overview," in Impact of Recent Computer Advances on Operations Research, Ramesh Sharda et al. (eds), North-Holland, New York, 1989, pp. 447-462.

P.A.W. Lewis, R.L. Ressler and R.K. Wood, "Variance Reduction Using Nonlinear Controls and Transformations," Communications in Statistics, Simulation and Computation, Vol. 18, No. 2, 1989.

W. Avery, G.G. Brown, J.A. Rosenkranz and R.K. Wood, "Optimization of Purchase, Storage and Transmission Contracts for Natural Gas Utilities," in progress.

G.G. Brown, G. Graves, H. Lange, C. Staniec and R.K. Wood, "Dual Decomposition Methods for Solving Multicommodity Flow Problems," in progress.

D. DeWolfe, J. Stevens, and R.K. Wood, "Determination of Military Reenlistment Bonuses," in progress.

R.K. Wood, "Primal Decomposition by Fictitious Play of a Two-Person Game," in progress.

G.G. Brown and M.P. Olson, "Dynamic Row Factorization in Large-Scale Optimization," in progress.

CONFERENCE PRESENTATIONS: G.H. Bradley, "Mathematical Programming Modeling Project - Overview," ORSA Conference on the Impact of Recent Computer Advances on Operations Research, Williamsburg, VA, January 3-8, 1989.

G.H. Bradley and Michael M. Mayer, "Optimization Modeling Environment - Mathematical Programming Modeling Project," CORS/TIMS/ORSA Joint National Meeting, Vancouver, May 8-10 1989.

R.K. Wood, "Primal Decomposition by Fictitious Play of a Two-Person Game," CORS/TIMS/ORSA Joint National Meeting, Vancouver, May 8-10 1989.

T.P. Harrison, G.H. Bradley and G.G. Brown, "Capital Allocation and Project Selection Via Decomposition," CORS/TIMS/ORSA Joint National Meeting, Vancouver, May 8-10 1989.

M.C. Puntenny, R.E. Rosenthal, and R.K. Wood, "A Network Reduction with a Logistics Application," CORS/TIMS/ORSA Joint National Meeting, Vancouver, May 8-10 1989.

G.G. Brown, S. Lawphongpanich, K.A. Podolak, "Port Operations Planning," CORS/TIMS/ORSA Joint National Meeting, Vancouver, May 8-10 1989.

D.D. DeWolfe, J.G. Stevens and R.K. Wood, "Determination of Military Reenlistment Bonuses," CORS/TIMS/ORSA Joint National Meeting, Vancouver, May 8-10 1989.

M.P. Olson, G.G. Brown, R.K. Wood and R. McBride, "Dynamic Factorization Approach for Solving the Multicommodity Transshipment Problem," CORS/TIMS/ORSA Joint National Meeting, Vancouver, May 8-10 1989.

G.H. Bradley, "Optimization Modeling Environment - Mathematical Programming Modeling Project (MP2)," KMS Software User Group Meeting, Monterey, CA, September 18-19, 1989.

G.H. Bradley and A. Geoffrion, "Capital Portfolio Optimization in a Telephone Company," ORSA/TIMS Joint National Meeting, New York, October 16-18, 1989.

THESES DIRECTED: M.P. Olson, LCDR, USN, "Dynamic Row Factorization in Large-Scale Optimization," Ph.D. Dissertation, June 1989.

K.P. Thurman, "Optimal Ship Berthing Plans," Master's Thesis, March 1989.

J.A. Marin, CPT, USA, "A Model for Optimizing Field Artillery Fire," Master's Thesis, March 1989.

E.A. Godat, LT, USN, "BGSTRIKE: An Integrated Tactical Decision Aid for Anti-Surface Warfare Commander (ASUWC) and Strike Warfare Commander (STWC)," Master's Thesis, March 1989.

R. L. Rubin, LT, USN, "The Optimal Allocation of SOSUS Display Resources," Master's Thesis, March 1989.

M.B. Sagaser, CPT, USMC, "A Computational Comparison of the Primal Simplex and Relaxation Algorithms for Solving Minimum Cost Flow Networks," Master's Thesis, March 1989.

K.W. Amster, "Scheduling Tests on the Naval Weapons Center Range Facilities," Master's Thesis, Sept. 1989.

A.S. Levitt, LT, USN, "Hypertext: Improved Capability for Shipboard Naval Messages," Master's Thesis, Sept. 1989.

LARGE-SCALE OPTIMIZATION

G.H. Bradley, Professor of Operations Research
G.G. Brown, Professor of Operations Research
R.K. Wood, Assoc. Prof. of Operations Research
Sponsor: U.S. Army Concepts Analysis Agency

OBJECTIVE: Develop theory and algorithms for solution of large-scale optimization models particularly as applied to fleet procurement/ management problems associated with helicopters, tactical wheeled vehicles and other systems.

SUMMARY: A decision support system was jointly built by teams at the U.S. Army Concepts Analysis Agency and the Naval Postgraduate School for long-term management of helicopter and vehicle fleets in the U.S. Army. This research developed new solution technologies for these types of problems which are becoming larger, more detailed and harder to solve. New model formulations were developed suitable for use with a solver employing a generalized network basis factorization.

PUBLICATION: G.G. Brown, R.D. Clemence, W.R. Teufert and R.K. Wood, "An Optimization Model for Modernizing the Army's Helicopter Fleet," Interfaces, forthcoming.

THESIS DIRECTED: R.W. Drash, LT, USN, "An Optimization Model for Modernizing the Navy's P3 Fleet," in progress.

SELECTOR/HEAVY ATTACK MODELING

G. G. Brown, Professor of Operations Research
A. R. Washburn, Professor of Operations Research
Sponsor: US Air Force XOX/FM

OBJECTIVE: Improve the efficiency, realism, and user-friendliness of the SELECTOR/HEAVY ATTACK software used by XOX/FM to plan air-to-ground munition provisioning.

SUMMARY: Accomplishments this year have been to use the GAMS/MINOS system to explore the effectiveness and efficiency of alternative formulations (Wirths' thesis) and to develop a new optimization algorithm that is fast enough to permit transfer of the current system to personal computers. Work on implementing constraints on weapon usage in the current (mainframe) system is still in progress.

PUBLICATIONS: A. R. Washburn, "Finite Methods for a Nonlinear Allocation Problem", NPS-55-89-003 (March 1989).

THESES DIRECTED: Capt. Klaus Wirths (Federal German Air Force), "A Nonlinear Programming Model for Optimized Sortie Allocation", Master's Thesis, March 1989.

DAMAGE AGGREGATION MODELS FOR WEAPONS SALVOS

J.D. Esary, Professor of Operations Research

Sponsor: Naval Undersea Warfare Engineering Station, Keyport, WA

OBJECTIVE: Develop reasonable planning models for estimating the aggregate damage caused by multiple hits from weapons salvos, initially for salvos directed against area targets.

SUMMARY: The estimation of the aggregate damage to be achieved as the result of multiple weapons hits is a fundamental aspect of strike planning. For area targets, at least two measures of effectiveness are pertinent, the expected percentage of the target which is damaged, and the probability that the damage to the target exceeds a threshold sufficient to regard the target as "killed." Models for estimating these measures are of interest generically, and specifically to various subgroups of the Joint Technical Coordinating Committee for Munitions Effectiveness. In the ASW context, internal systems disablement resulting from multiple hits on a submarine hull by nonpenetrating lightweight torpedoes can be regarded at the effect of an attack on an area target. Results documented during this period concern an empirical rule for estimating the expected percentage of damage to an area target, which has been used and which proves to be optimistic from the perspective of a plausible model, and an alternative empirical rule which is conservative from the same perspective.

PUBLICATIONS: J.D. Esary, "A Comparison of an Empirical Rule for Aggregating Damage from a Weapons Salvo to a Plausible Model for the Same Purpose," Working Paper on Damage Aggregation, Naval Postgraduate School, April 1989.

J.D. Esary, "Damage Aggregation for a Weapons Salvo by an Empirical Rule Related to the Poisson Approximation to the Binomial," Working Paper on Damage Aggregation, Naval Postgraduate School, July 1989.

ACOUSTIC COVER AND DECEPTION

R.N. Forrest, ASW Academic Chairman and Professor of Operations Research
J.N. Eagle, Associate Professor of Operations Research
Sponsor: Chief of Naval Operations, OP 71

OBJECTIVE: The objective of the research was to investigate the impact of acoustic cover and detection devices on the localization effectiveness submarines.

SUMMARY: Analytic and simulation models have been developed that can be used to estimate bounds on localization times as a function of decoy numbers and target area size.

PUBLICATIONS: R.N. Forrest, "Search Times and False Targets," Naval Postgraduate School Technical Report, NPS-71-89-001, July 1989.

ASW TACTICAL DECISION AIDS

R.N. Forrest, ASW Academic Group Chairman and Professor of Operations Research
J.N. Eagle, Associate Professor of Operations Research
Sponsor: Chief of Naval Operations, OP 71

OBJECTIVE: The objective of the research is to analyze the search and detection models that are the basis for the ASW tactical decision aid and models which are possible alternatives to them. The primary objective of the analysis is to establish the relative capabilities of these models.

SUMMARY: The ASW tactical decision aid models are being analyzed thorough the use of both analytical and simulation models.

DDN PERFORMANCE ANALYSIS

D.P. Gaver, Distinguished Professor of Operations Research
P.A. Jacobs, Professor of Operations Research
Sponsor: Defense Communications Agency

OBJECTIVE: To use probability modeling techniques to study the effects of Data Defense Network parameters on the network performance (response time).

SUMMARY: Stochastic models have been developed to study the effect of input rate, retransmission time interval, and buffer capacity on network performance. A weekly seminar has been held to develop increased understanding of important issues.

PUBLICATIONS: D.P. Gaver and P.A. Jacobs, "Probabilistic Evaluation of a Packet Switching Protocol," in progress.

STOCHASTIC MODELING AND DATA ANALYSIS

D.P. Gaver, Distinguished Professor of Operations Research
P.A. Jacobs, Professor of Operations Research
Sponsor: Office of Naval Research

OBJECTIVE: Topics for investigation have been the formulation construction and investigation of probabilistic models for problems arising in maintenance and logistics, (e.g. scheduling of the repair of certain failure-prone items, inventory stocking problems for deployment, assessment of equipment reliability and availability from failure and inspection data, etc.) and problems of performance analysis of computer/communication systems, such as well may occur in military C3I. Attention has also been directed to problems of modeling and predicting human reliability, using especially non-linear and non-Gaussian regression models with hierarchical random effect terms to represent individual (crew) variations in response time.

PUBLICATIONS: D.P. Gaver and P.A. Jacobs, "Inferring Finite-time Performance in the M/G/1 Queing Model," Naval Postgraduate School, 55-89-01, to appear in Queuing Systems and Application.

D.P. Gaver and H.B. Mutlu, "An Operational Analysis of System Calibration," Naval Research Logistics 36, pp. 373-382, 1989.

D.P. Gaver, E.G. Coffman Jr., L. Flatto, "Height Distributions in Data Communication Buffers with Locking Protocols," Submitted to Stochastic Models.

CONFERENCE PRESENTATIONS: D.P. Gaver, J.A. Morrison, and S. Pilnick, "Multi-type Repairman Problems with Queue-Sensitive Control," ORSA/TIMS Joint National Meeting, New York, NY, October 16-18, 1989.

D.P. Gaver, P.A. Jacobs, and P. Purdue, "Topics in Finite-Time Inference for Service Systems," TIMS XXIX, Osaka, Japan, July 23-26, 1989.

THESES DIRECTED: S.E. Pilnick, CDR, USN, "Combat Logistic Problems" Ph. D, June 1989.

D.H. Bae, MAJ, Korean Air Force, "Models for the Detection Time of Targets, M.S., September 1989.

STATISTICAL ANALYSIS OF MULTIVARIATE OBSERVATIONS

D. P. Gaver, Distinguished Professor Operations Research
P.A. Jacobs, Professor of Operations Research
Sponsor: National Security Agency

OBJECTIVE: To apply statistical and probabilistic techniques to problems posed by the sponsor.

SUMMARY: Research was conducted on DOD/DON problems posed by the sponsor. The research is classified SECRET.

DEVELOPMENT OF THEORY OF COMBAT

W.P. Hughes, Jr., Adjunct Professor of Operations Research
Sponsor: Office of CNO, OP-098

OBJECTIVE: To combine and extend concepts in the Investigator's book, "Fleet Tactics," with his research with The Military Conflict Institute, to develop a theory that includes Interrelationships between force, maneuver, and suppression as an alternative to attrition-centered analysis of combat.

SUMMARY: Now, midway in the second year, work completed to date consists of two products: 1) a detailed outline of the theory, including precise definitions, and 2) the research report listed below under publications. The report explains the role of command and leadership within the framework of the general theory. Command is described as the combat function that activates combat power and is defined in terms of a single, comprehensive command equation. Core concepts are the relationships between forces (tangible elements of combat power), combat potential, power effectiveness, results, and an outcome. Work now in progress will lead to publication of a new research report in 1990 entitled "Combat Science: An Organizing Study." This report will be built on six fundamental statements of accepted truth about combat, called axioms. It will put particular emphasis on the nature of force as a real combat phenomenon, with application of force (the dynamic force) treated at the organizing, unifying concept.

PUBLICATIONS: W.P. Hughes, Jr., "Command and Control Within the Framework of a Theory of Combat, "USNPS Technical Report, NPS-55-90-05, May 1989.

CONFERENCE PRESENTATION: W.P. Hughes, Jr., "Battle Physics: The fundamental Nature of Combat Momentum," The Military Conflict Institute, 12th Working Meeting, October 1989.

ESTIMATES OF SPATIAL VARIABILITY

L. Johnson, Assistant Professor of Operations Research
Sponsor: Research Council

OBJECTIVE: Examine measures of spatial variance useful for estimating the variogram, a quantity needed for finding the best linear unbiased estimates of a geographic variable, (i.e., Krige estimates).

SUMMARY: This research examined measures of spatial variance useful for estimating the variogram when geographic data are irregularly spaced. A new estimate called mean local variance was explored for its usefulness in estimating the variogram. Properties of different estimates of the variogram were compared. The effort of reliability of variogram estimates on the Krige estimates was also examined.

PUBLICATION: L. Johnson, "An Estimate of Spatial Variance" In Progress.

RANGE CALIBRATION STUDIES

L. Johnson, Assistant Professor of Operations Research
R.R. Read, Professor of Operations Research
Sponsor: NUWES, Naval Underwater Weapons Engineering Station

OBJECTIVE: To enhance the algorithm of range calibration by better estimating the velocity of sound field.

SUMMARY: The possibility of applying Krige estimates and the estimation of sound velocity field is being explored. There is also a "seasonal" effect in the velocity field. Methods for incorporating this effect into the estimation scheme are being developed.

PUBLICATIONS: L. Johnson, "An Estimate of Spatial Variance," In Progress.

MARKET ANALYSIS FOR THE YEAR 2000

L. Johnson, Assistant Professor of Operations Research
G. Thomas, "Associate Professor of Administrative Sciences
L. Solnick, Associate Professor of Administrative Sciences
Sponsor: USAREC (US Army Recruiting Command)

SUMMARY: This research is involved in characterizing the commute behavior of Army reservists' distance traveled from home to their drill site. It is important to the Army for recruiting considerations such as market size in a particular location. This project and data have been used in the data analysis class for one midterm project. A student (1990) that is interested in doing a thesis related to this. It is likely to be funded for 65K. Two talks were presented on this research at national meetings. In addition, a paper was published on this work in 1989. Another paper has been submitted.

PUBLICATIONS: L. Johnson and G. Thomas, "A Maximum Likelihood Method for Characterizing Commute Behavior," In Progress.

CONFERENCE PRESENTATIONS: L. Johnson and G. Thomas, "Modeling Reservists' Commute Behavior," Proceedings of 1989 Annual ASA Conference on Social Statistics.

G. Thomas, "Distance to Work Behavior," American Statistical Association 1989 Winter Conference on Social Statistics.

VALIDATION AND COMPARISON OF SIMULATION MODELS

K. Kang, Adjunct Professor of Operations Research
Sponsor: NPS Research Council

OBJECTIVE: Investigate statistical aspects of simulation model validation.

SUMMARY: Stochastic models have been developed for digital transmission error analysis. Markov chain first passage time analysis was applied to derive higher moments of the misframe times. It is shown that the misframes are always approximately exponential in distribution. This model will be used for the simulation study of parameter estimation, variance reduction, and model validation.

PUBLICATION: K.Kang, M.P. Bailey, and E.H. Eu, "Statistical Properties of Out-of-Frame Detection Schemes for Digital Transmission Systems," Submitted to IEEE Transactions on Communication.

STATISTICAL SUPPORT FOR THE JOINT OIL ANALYSIS PROGRAM

H.J. Larson, Professor of Operations Research
T. Jayachandran, Professor of Math
Sponsor: Kelly Air Force Base, Texas

OBJECTIVE: Investigate the placement and efficacy of the decision guideline limits for oil analysis techniques, published in the Joint Oil Analysis Program laboratory manual; using actual used engine oil results, establish formulas for conversion between atomic absorption (AA) and atomic emission (AE) spectrometer readings.

SUMMARY: The Joint Analysis Program is a tri-service program in charge of using spectrometric analyses of used oil samples to monitor heath of critical military equipment (engines, gear boxes, switches, etc.). The concentrations of many different metals are monitored and compared with tabulated "critical" values to determine if the equipment is exhibiting an unusual wear condition. Appropriate recommended action is then taken, based on the results of these analyses. The two co-investigators have been conducting statistical studies to examine the efficacy of the program and have been recommended several modifications and changes tot he procedures over the past several years. Many of these recommendations have been implemented and now are operational. A major task for this past year was the investigation of the oil analysis readings, for Air Force engines, submitted to the central oil analysis repository during FY88; this study was aimed at investigating the positions of the published "critical" values, for different engine types for both AE and AA instruments, in terms of consistency and usefulness. As was not unexpected, the data provided for the study suffered a great deal from apparent internal inconsistencies and errors of either transmission or data entry. In spite of these shortcomings, it appears that the "critical" values could generally be tightened to lower the chances of false calls. Since the Air Force continues to employ both AE and AA instruments in making daily analyses, and these two instruments generally produce quite different numerical results from analyses of the same samples, there is interest in establishing statistical relationships between readings from the two instruments to facilitate the formulation of recommendations. Unfortunately the lack of sufficient accurate data for establishing such relationships denies the development of meaningful and reliable formulas for this problem.

PUBLICATION: H.J. Larson and T. Jayachandran, "An Examination of Some B0003 Data," Submitted.

A COLUMN-GENERATION APPROACH TO A TIME-SENSITIVE DEPLOYMENT

S. Lawphongpanich, Assistant Professor of Operations Research
R.E. Rosenthal, Professor, Professor of Operations Research
Sponsor: Oak Ridge National Laboratory

OBJECTIVE: To develop efficient algorithms for planning military deployments in time-sensitive or crisis situations.

SUMMARY: One of the questions which are of great concern in planning a deployment is whether a given plan can be supported logistically. One approach to this question is to construct shipping schedules for the available lift assets. If these schedules deliver all movement requirements to their destinations by the required due dates, then the deployment plan is feasible. Otherwise, the plan is not feasible. The problem of constructing schedules for lift assets can be formulated as an integer programming problem. However, this problem is quite large and its solution time is too long to be practical in crisis situations. As an alternative, we developed a procedure to approximate the minimum number of assets required to accomplish a given deployment plan. If this required number of assets is smaller than the available number, then the plan is feasible. Otherwise, the plan is not feasible. This procedure was implemented in WATFOR77 and is executable on a microcomputer. Based on several examples, the procedure appeared to be fast. Moreover, it can be used independently or as a preliminary estimator in a more detailed deployment analysis computer package.

PUBLICATIONS: S. Lawphongpanich and R.E.Rosenthal, "A Multi-Modal Deployment Planning Problem," Interim Report, May 1989.

S. Lawphongpanich and R.E. Rosenthal, "Estimating the Minimum Number of Assets to Support a Deployment," Final Report, October 1989.

THESES DIRECTED: S. Buvik, LCDR, Royal Norwegian Navy, "An Algorithm for Generating Ship Schedules for a Crisis Deployment Planning Problem," Master's Thesis, Sept. 1988.

N.R. Lima, LT, Brazilian Navy, "A Column Generation Technique for a Crisis Deployment Planning Problem," Master's Thesis, Sept. 1988.

DECOMOSITION TOPICS IN LARGE-SCALE OPTIMIZATION

S. Lawphongpanich, Assistant Professor of Operations Research
Sponsor: National Science Foundation

OBJECTIVE: To develop effective algorithms for large-scale optimization models. The development includes both theoretical and computational investigation of decomposition techniques which allow division of the problem into more tractable subproblems.

SUMMARY: The initial phase of this research was sponsored by the NPS Research Foundation. During this initial phase, it was established that adding a line search step to Generalized Linear Programming (GLP) reduces the computational time by approximately fifty percent for linear and quadratic integer programming problems. Since then, we showed that GLP with the line search step theoretically converges to an optimal solution and successfully applied it to the traffic assignment problem. Furthermore, we also extended the convergence result to variational inequality problems which is a more general class of problems. Variational inequality problems include optimizations problems as well as equilibrium problems.

PUBLICATIONS: D.W. Hearn and S. Lawphongpanich, "A Dual Ascent Algorithm for Traffic Assignment Problem," Transportation Research, forthcoming.

D.W. Hearn and S. Lawphongpanich, "Generalized Linear Programming with Line Searches," Proceedings of the 28th IEEE Conference on Decision and Control, forthcoming.

CONFERENCE PRESENTATIONS: D.W. Hearn and S. Lawphongpanich, "Generalized Linear Programming with Line Searches," 28th IEEE Conference on Decision and Control, Tampa, FL, December 13 - 15, 1989.

S. Lawphongpanich, "Two Algorithms for Linearly Constrained Convex Programs," ORSA/TIMS Meeting, New York, NY, October 16 - 18, 1989.

RESYSTEMIZATION MODELLING SUPPORT

A.W. McMasters, Professor of Operations Research and Administrative Sciences
Sponsor: Navy Fleet Material Support Office

OBJECTIVE: To develop a Wholesale level inventory model for the Navy to use to replenish their inventories of repairable items; the object function of this model should be related to readiness.

SUMMARY: A new inventory model for managing repairable at the Wholesale or Inventory Control Point (ICP) level is needed to determine when to replenish repairable items. This model should have the same objective function as the Wholesale provisioning (or first buy quantity) model developed on this project between 1982 and 1986; namely, the minimization of the aggregate Mean Supply Response Time (MSRT). The intent of this model is to base decisions for replenishment buys and repair inductions into depots upon the Ready-for-issue (RFI) inventory position (IP). The completion of model development depends on describing the probability distribution of the IP. Work this past year examined the influences of the model parameters on the use of computer simulations. In addition, since a consumable item can be viewed as a limiting case of a repairable item and since such items are also managed at he Wholesale level, and MSRT model was developed for consumable items and evaluated with actual item data against the current consumable model used by the ICPs. The MSRT model was found to be superior for the major measures of effectiveness used by the ICPs.

CONFERENCE PRESENTATIONS: A. McMasters, "A New Replenishment Model for the Wholesale Level in the V.S. Navy," SOLE/NPS 7th Annual Logistics Symposium, Monterey, CA., 13 May 1989.

THESES DIRECTED: R.E. Boike, LCDR, SC, USN, and T. H. Stringer, LCDR, SC, USN, "An Evaluation of the Model for Wholesale Consumable Items," M.S., December 1989.

M.D. Dexter, LT, SC, USN, "Initial Research on an Inventory Control Process for Low Attrition Repairable Items," M.S., December 1989.

STOCK POINT EXPERT SYSTEMS

A.W. McMasters, Professor of Operations Research and Administrative Sciences
Sponsor: Naval Supply Systems Command

OBJECTIVE: To develop expert systems to facilitate the decision making of inventory managers of Navy Stock Points.

SUMMARY: For the past four years, NPS have been developing expert systems to aid the inventory manager at Navy Stock Points. Systems for deciding how to handle overdue orders from the Defense Logistics Agency (Delinquent Dues) and determining the causes of inventory errors (Causative Research) have been developed. This year the effort concentrated on the managing of hazardous materials. At present, such items are stored and managed on strictly an intuitive basis. However, the danger in this approach is that two materials may be stored together which are dangerous (i.e., cause and explosion) when combined. A major need is for a warehouse person to be able to distinguish the nature of an item's hazard by knowing its Navy stock number and then be able to immediately decide where to store a shipment received from a supplier. Such a system is in the final states of development.

MARINE CORPS MANPOWER RESEARCH PROJECT (FY1989)

P.R. Milch, Professor of Operations Research and Statistics
Sponsor: Headquarters, Marine Corps

OBJECTIVE: Investigate two separate topics: 1) the feasibility of civilianizing jobs at Marine Corps commands; and 2) the management of officer career paths with special attention to the impact of the newly created joint duty assignment on such career paths.

SUMMARY: 1) The Fleet Assistance Program (FAP) at the Camp Pendleton, CA Marine Corps Base was selected to illustrate the methodology of how a feasibility study of civilianizing Marine Corps jobs may be carried out. The methodology consists of two phases. In the first phase a "combat essential" criterion is applied to each billet type to determine eligibility for civilianization. To be eligible a billet type must not contain any of seven characteristics that are associated with the "Combat essential" criterion. The second phase consists of establishing and then comparing the military and civilian cost factors associated with each billet type identified in phase one and making recommendations accordingly. 2) An interactive computer model, TITLE IV, was produced which has the ability to forecast the effect of manpower decisions with regard to compliance with Title IV regulations of the Goldwater-Nichols Department of Defense Reorganization Acts passed by Congress in 1986. The model uses several pools of Marine officers of varied levels of joint duty experience and traces them throughout their career as they rotate in and out of joint duty billet categories. Some specific billet fill strategies are used to demonstrate the usefulness of the model.

THESES DIRECTED: I.B. Bressler, "The Civilianization of Marine Corps Billets: A Methodology," M.S., June 1989.

R.L. Miller, "Marine Corps Joint Assignment Model Under Title IV of Goldwater-Nichols Act of 1986, M.S, September 1989.

NAVY OFFICER CORPS CAREER STRUCTURE ANALYSIS (FY1990)

P.R. Milch, Professor of Operations Research and Statistics
Sponsor: Officer Allocation and Distributable Strength Projection Branch
Naval Military Personnel Command (NMPC-454)

OBJECTIVE: To construct interactive computer models to facilitate the personnel planning tasks of NMPC-454 based on the previously built FORECASTER model.

SUMMARY: The FORECASTER model was reprogrammed thereby achieving a computationally much more efficient model. The newer version was tested by analyzing the effects of the Goldwater-Nichols Department of Defense Reorganization Act on the career paths of Tactical Aviation officers. More work remains to be done to change both the input and output structures of the model to meet the specific needs of personnel planners at NMPS-454, while making simultaneous use of the model to analyze topical issues of the Navy officer community. In a separate effort, another interactive personnel planning model, called FORCE, was constructed to enable community managers to forecast future officer force structures by grade and years of service in a simple and efficient manner using current inventories, historical continuation rates and planned accessions and promotion rates. This model was also tested to analyze topical issues in the Navy Nurse Corps.

THESES DIRECTED: R.B. Drescher, "The Effect of the Goldwater-Nichols Department of Defense Reorganization Act on Tactical Aviation Pilot and NFO Career Paths," M.S., September 1989.

K.A. Doyle, "Future Navy Nurse Corps Grade Distribution: An Analysis of the Impact of Relief from Constraints Imposed by the Defense Officer Personnel Management Act of 1981, M.S., December 1989.

NAVY OFFICER CORPS CAREER STRUCTURE ANALYSIS (FY 1989)

P.R. Milch, Professor of Operations Research and Statistics
Sponsor: Office of the Deputy Chief of Naval Operations
Office of Professional Development (OP-13)

OBJECTIVE: To provide personnel managers of various Navy officer communities with a planning tool to facilitate the management of career paths of Navy officers in an environment of ever changing billet needs, new laws and policies effecting the Navy.

SUMMARY: A new model, called FORECASTER, was constructed and specifically adapted to the Surface Warfare Officer Community. This model was then used to investigate the impact of the Goldwater-Nichols Department of Defense Reorganization Act on the career paths of surface Warfare Officers.

CONFERENCE PRESENTATIONS: P.R. Milch and J.L. Johnson, Jr., "An Interactive Computer Model to Forecast Navy Officer Distribution," Joint National ORSA/TIMS Meeting, New York City, 18 October 1989.

THESIS DIRECTED: J.L. Johnson, Jr., "An Analysis of the Joint Reorganization Act's Impact on Personnel Flow in the Surface Warfare Officer Community," M.S., March 1989.

HUMAN FACTORS IN COMBAT MODELS

S.H. Parry, Associate Professor of Operations Research
Sponsor: U.S. Army DSC Personnel (MANPRINT)

OBJECTIVE: To design a sequence of experiments and specify combat model parameters for a linkage between selected human factors and their effects on combat outcomes.

SUMMARY: Current combat models focus on the engineering aspects of combat outcomes utilizing data generated by Material developes. Some of these data may consider human factors, but are generally undocumented. This research has focused on the design and implementation of experiments to determine the linkage required between the perceived real world and combat models. Many other efforts have provided "laundry lists" of human factors which should be considered, with no suggestion of how to make the quantitative connection, while others focus on "human factor data" gathered in environments having little or no relationship to combat scenarios. In view of the new focus of Defense analysis for the new environment, it is double unclear how "human factors" research should progress. It is obvious that they will become more important, but not necessarily in the context of current force-on-force models.

THESES DIRECTED: T.Schroth, "An Introduction to Human Factors and Combat Models," M.S., March 1989.

R. Geiger, "Experimental Design and Analysis of M1A1 Commander/Gunner Performance During CONOPS Using UCOFT," M.S., September 1989.

AIRLAND MODELLING APPLICATIONS

S.H. Parry, Associate Professor of Operations Research
A.L. Schoenstadt, Professor of Mathematics
Sponsor: U.S. Army TRADOC Analysis Command

OBJECTIVE: To continue the implementation of the Generalized Value System (GVS) in current Army models and to investigate the use of renewal models for combat representations.

SUMMARY: During the FY89 Research period, the focus of implementing the GVS shifted to implementing the future state decision methodology to the EAGEL model, a new Army initiative employing LISP and object oriented programming techniques as an architecture for Corps-Division level models. Based on the Technical Report produced, as well as many interactions with the feasible alternative to current state decision table approaches used in existing combat models. This effort will be continued into FY90. The other initiative involving the use of Renewal models as surrogates for simulations holds great promise. Even though this report is written for FY89, the recent events have dictated a new focus in modelling methods. Our approach seems to have significant potential for the future.

PUBLICATIONS: S.H. Parry and A.L. Schoenstadt, "Future State Decisionmaking Under the Generalized Value System Architecture," NPS Technical Report, NPS-53-89-013, July 1989.

CONFERENCE PRESENTATIONS: S.H. Parry, "The Use of Renewal Models as a Surrogate for Combat Simulations," 58th Military Operations Research Symposium, Fort Leavenworth, KS, June 1989.

THESIS DIRECTED: H. Argo, "Analysis of a Lance Missile Platoon Using a Semi Markov Chain," M.S., September 1989.

VOICE VERIFICATION RELIABILITY/RESISTANCE

G.K Poock, Professor of Operations Research
Sponsor: Naval Ocean Systems Center

OBJECTIVE: Investigate the user friendliness, reliability and noise susceptibility of a commercially available speech verification biometric system.

SUMMARY: Speech verification biometric equipment tries to verify a user wishing to gain entrance to a facility or a computer, by examining characteristics of the user's voice when he/she talks to the verifier. By comparing characteristics of the user's voice to samples taken long before and subsequently stored in memory, the machine verified or denies the user access. Results of this research indicate the particular device examined admitted users about 68% of the time on first attempt to gain access, but if one allowed a user up to three attempts, then about 95% of the users gained access somewhere between one and three attempts. Noise did not have as much effect as anticipated. Threshold criteria on how close the match should be to the store template, did affect access. The tighter the criteria, the lower the successful access rate.

THESIS DIRECTED: J. Brewster, CPT, USAF, "Examining the Effects of Background Noise Levels on a Voice Verification Machine," M.S., June 1989.

RANGE CALIBRATION STUDIES

R.R. Read, Professor of Operations Research
Sponsor: Naval Undersea Weapons Engineering, Keyport, WA

OBJECTIVE: NUWES operates several underwater vehicle tracking ranges of the short baseline type. I.E. each sonar array in the (bottom based) system of arrays independently produces three dimensional position locations for the target vehicles during their stay in the arrays domain of attraction. Thus the overlap regions of adjacent arrays form regions of common tracking and (intended) coherent results. Serious mismatches occur with great regularity. They are a consequent of systematic errors from perhaps several sources. The objective of this continuing project is to study the structure of three possible error sources, using data from the overlap regions, and recommended corrective action.

SUMMARY: The three error sources are 1) the ray tracing method; 2) timing synchronization; 3) location and orientation of the sensing arrays. During this past period considerable headway was made on source 1) and 2). Data were collected for twelve days spanning September 1988 through July 1989. The data consists of the depth velocity profile of the water for all test days, and all vehicle tracking for those days. The depth velocity profile is unique for a day's operation and a source of mischief when one is seeking to construct policies for treating systematic error sources. Programs have been written to select appropriate crossover data in the overlap regions. They have been exercised in the and useful data for study have been made available.

The timing synchronization error model has two components: offset and drift. The systematic errors that exist int he overlap regions can be reduced substantially by making corrections of this type, and algorithms have been developed and programmed to do this. However, in the interest of continuity, any corrective action of this type must be applied to the entire track, and this includes other overlap regions that do not necessarily have the same values for offset and drift. Further, these effects are confounded with the other systematic error sources. Thus it is necessary to identify the reality of these corrections and allocate them to their proper origin. Plans have been made to identify the timing synchronization errors in terms of experimental days and differing vehicles.

ATTRITION RATE GENERATION FOR MANPOWER MODELS

R.R. Read, Professor of Operations Research
Sponsor: U.S. Marine Corps, headquarters, MP 40

OBJECTIVE: This is a continuing project dealing with the development of attrition rate generation methods for use in forecasting the numerous and various attrition loss rates that appear in Marine Corps Officer manpower planning models. Particular attention is to be paid to the "small cell" problem. That is, the various application models may cross classify officers according to rank, year of commissioned service, military occupation specialty, education, service component, etc. Such cross classifications tend to produce a rather large number of cells containing few personnel, (low inventory).

SUMMARY: In the current period, we have integrated the cell aggregation techniques with the "shrinkage" type estimators studied previously. Aggregation techniques involve two steps. First, one must establish priorities for combining low inventory cells into moderately larger aggregates of cells that exhibit similar attrition rate behavior. This was accomplished using clustering algorithms. Constraints were inserted so that certain aspect of the Marine Corps organizational structure were not distributed. The resulting cells have non trivial inventory values, but (usually) lack sufficient size to provide stable empirical attrition rates. Second, these intermediate level cells were further aggregated so that modern multiparmeter estimation schemes can be applied. Thus, further variability reduction is realized. The aggregation methodology is in good order and we have recommended implementation. Empirical Bayes shrinkage type estimators have been studied previously. A recommendation has been made for use in one year lead time forecasting.

THESIS DIRECTED: J.M. Misiewicz, MAJ, USMC, "Extension of Aggregation and Shrinkage Techniques Used in the Estimation of Marine Corps Officer Attrition Rates," M.S., September 1989.

OPERATIONS RESEARCH MODELING OF ANTI-SATELLITE ARCHITECTURES

R.E. Rosenthal, Professor of Operations Research
Sponsor: Naval Space Command

OBJECTIVE: This is a project to analyze the design and operation of various anti-satellite (ASAT) architectures using optimization.

SUMMARY: The primary problem addressed in this research is ASAT targeting. The U.S. Space Command (SPACECOM) is currently testing a system developed in LCDR S.A. Tisdale's recent thesis, which was directed by Professors Eagle and Rosenthal. This work will extend the existing system by looking at the nonlinearities arising from alternate battle management strategies, such as shoot-shoot-look, and at nonlinearities arising from tactical value of individual members of constellations of target satellites. This project began in Fall, 1989.

COMBAT LOGISTICS DECISION AIDS

D.A. Schrady, Professor of Operations Research
Sponsor: Commander, Second Fleet

OBJECTIVE: Develop a system of data, models, storage, retrieval, and processing to provide the tactical commander of a battle group or force with the ability to predict his underway replenishment requirements and to see the interactions between tactics and logistics in his tactical decision making.

SUMMARY: Combat logistics have in the main not been practiced since World War II, and fleet exercises generally suppress logistics in favor of using valuable exercise time to practice other tactical skills. Battle force/group logistics coordinators have no tools to seeks to develop such tools in a system for use in the battle force/group command center afloat. Data, predictive models, and planning factors have been developed, compiled and documented. Work on microprocessor implementation is proceeding.

PUBLICATIONS: D.A. Schrady, "Measures of Effectiveness in Logistics," NPS Technical Report, NPS-55,89-07, May 1989.

D.A. Schrady, "Running Out of Ordnance is an Absolute Combat Stopper," Underway Replenishment Journal, July 1989.

D.A. Schrady, "Planning Factors for Combat Logistics Commodities Usage and Replenishment (U)," NPS Technical Report, NPS-55-90-02, October 1989. (SECRET).

D.A. Schrady, Memorandum to COMSECONDFLT Subj: Comments on COMSECONDFLT TACMEMO ZZ00001-1-85, Battle Force/Group Logistics Coordinator, 20 November 1989. (CONFIDENTIAL).

THESES DIRECTED: J.F. Weppler, LCDR, USN, "Aircraft Carrier Battle Group Logistics Defined in Terms of Warfighting Capability (U)," M.S., March 1989. (SECRET).

S.M. Harris, LT, USN, "Comparison of Three Combat Logistic Force Models," M.S., March 1989.

C3I COUNTER-MEASURES RESEARCH

R. Thackery, Professor, Department of Operations Research
M. Sovereign, Professor of Operations Research
J. Sternberg, Professor of National Security Affairs
C Jones, Professor of Administrative Sciences
Sponsor: Chief of Naval Operations

OBJECTIVE: To develop a method for assessing the potential impact of Soviet Combat C31 on the implementation on PACOM strategy.

SUMMARY: During the past year attention was focused on developing the concept for a wargame structured to explore the impact of varying levels of C3I information on command and control decisions effecting mission effectiveness. The purpose is to develop a credible means for assessing the communication levels and information sources that are most important to battle force commanders in PACOM. The game is visualized as a combination of an open seminar format with computer support. A software study under contract has identified the existing software to support the game are being prepared at the basis for a software contract. The concept for the game was presented in a paper at the 1989 Symposium on Command and Control Research and is included in the Symposium Proceedings. A series of presentations were also made in OPNAV and SPAWAR to senior officers concerned with C3I. Work has also proceeded on the development of assessments of operational and AAW engagement capabilities, (for a range of conditions), working closely with Navy analytic and tactical organizations. Visits have been made to Naval Weapons Center, China Lake, Training Group Pacific and Naval Ocean System Center.

PUBLICATIONS: J. Sternberg, C. Jones, R. Thackery, and L. Bruner, Published by SALC, McLean, VA, 22102, p. 193-197, August 1989.

CONFERENCE PRESENTATIONS: J. Sternberg, C. Jones, R. Thackery, and L. Bruner, "The Assessment of the Importance of Information in the Execution of the Maritime Strategy," Proceedings at the 1989 Symposium on Command and Control Research, p. 27-29, June 1989.

CUMULATIVE SEARCH-EVASION GAMES: DEVELOPMENT AND EVALUATION

A.R. Washburn, Professor of Operations Research
J.N. Eagle, Associate Professor of Operations Research
Sponsor: Office of Naval Research

OBJECTIVE: Develop computational methods for solving two-person-zero-sum search games where searcher and evader are both free to move.

SUMMARY: CSEGs are games where the objective is a sum over time of payoffs, each payoff depending only on the position of the searcher and evader at that time. Such games can be solved using either the Brown-Robinson method or linear programming. Previous search games have been restricted to only a few cells, often two. We have solved games with up to 25 cells.

PUBLICATIONS: J.N. Eagle, "Cumulative Search-Evasion Games," Submitted to Naval Research Logistics.

CONFERENCE PRESENTATIONS: J.N. Eagle, "Cumulative Search Evasion Games," 57th MORS, June 1989.

A.R. Washburn, "Cumulative Search-Evasion Games," New York, ORSA/TIMA, October 17, 1989.

SEQUENTIAL ESTIMATION OF MAINTENANCE POLICIES

L.R. Whitaker, Assistant Professor of Operations Research
Sponsor: NPS Research Council

OBJECTIVE: Develope statistical methods to estimate and then update optimal maintenance policies based on maintenance history data.

SUMMARY: In the past year, we concentrated on nonparametric estimation of an optimal age replacement policy. A tractable, and intuitively appealing sequential estimator was developed, and shown to be consistent. More importantly, the actual cost incurred while estimating the optimal policy were shown to converge to the costs that would have been incurred had the optimal policy been in use all along. Simulation was used to further study small and large sample properties of this estimation procedure, verifying that it indeed substantially better than the competitors. Some progress was made in the analogous parametric framework.

PUBLICATIONS: G. Aras and L.R. Whitaker, "Sequential Estimation of an Optimal Age Replacement Policy: Nonparametric Approach," In Preparation.

CONFERENCE PRESENTATIONS: L.R. Whitaker, "Sequential Estimation of an Optimal Age Replacement Policy," Annual Joint Meeting of the Institute of Mathematical Statistics and the American Statistical Association, Washington, DC, 6-10 August 1989.

CONTINUOUS RELIABILITY GROWTH MODELS

W.M. Woods, Professor of Operations Research
Sponsor: Naval Air Systems Command

OBJECTIVE: Analyze the effect of failure discounting on the accuracy of two continuous reliability growth models and provide a computer program that can be used by DOD agencies and contractors for evaluating the impact of proposed failure discounting scenarios on the accuracy of these reliability growth models.

SUMMARY: Reliability growth management and analysis has become an important quality function in DOD procurement. Accurate reliability growth models are needed that allow the removal of failures or fractions of failures after corrective actions are made and subsequent testing show no repeated failures for the same source (failure discounting). A computer program was developed that measures the impact of a wide variety of failure discounting scenarios on the accuracy of two continuous reliability growth models. These programs were used to show the results of numerous failure discounting scenarios. The results show that failure discounting degrades the accuracy of cumulative reliability growth models more than it does for non-cumulative models. Also, a modified non-cumulative version of the well known AMSAA reliability growth model is more accurate than the AMSAA model itself.

THESES DIRECTED: S.L. Negus, LT, USN, "Evaluation of a Modified AMSAA Continuous Reliability Growth Model Using Failure Discounting and Weighting Factors," M.S., September 1989.

R. Bund, MAJ, Federal Republic of Germany Armed Forces, "Evaluation of a discrete Modification of the Continuous AMSAA Reliability Growth Model," M.S., March 1989.

DEPARTMENT
OF
PHYSICS

DEPARTMENT OF PHYSICS

During FY89, the research activities in the Physics department consisted of 31 identified individual projects.

The majority of these projects (75%) were funded through the Navy Direct Funding mechanism. The rest was external funded as Reimbursable. The direct funded projects involved Navy sponsors in an advisory capacity. These sponsor were NAVSEA, NCSC, NEPRF, NSWC, NRL, ONR, OPNAV 09, SPARWAR. Non Navy sponsors of the reimbursable funds were: Army, DARPA, NASA, SDIO, AFWL.

The projects fall naturally into five groups. They are: 1) Physical Acoustics, 2) Electro-Optics/Infrared Technology, 3) Space and Plasma Physics, 4) Directed Energy and Radiation Physics, and 5) Environmental Physics.

Although broadly based, this research program is the result of a long tern carefully orchestrated evolution, designed to explore the physics of areas where modern technology, particularly Naval weapons technology, interfaces and is limited by our understanding of the natural environments. As a group, the department specializes in the physics of the interface between weapon systems and environment. The nature and significance of the research in each area is outlined here.

PHYSICAL ACOUSTICS

The department has now one of the strongest and largest group in physical acoustics in the nation, with 8 faculty members participating in FY89. The research in this area in the department falls into five categories. a) Ocean bubble dynamics, b) Acoustic sensor technology, c) Thermoacoustic energy processes, d) Transducer physics, and e) Wave Turbulence. The interaction of sound and Ocean Bubble swarms is investigated by Professor Atchley which led to the development of a dual frequency method of measuring size spectrum of bubble clouds and the damping constant of bubble oscillations. In the area of sensor technology work continued on the development of the fiber optic sensor system (Garrett) and the design of the Space Shuttle Vibroacoustic Experiment. Work on the fiber optic sensor system concentrated on a flexural plate, fiber optic, interferometric, acceleration canceling, omnidirectional hydrophone which appears to have the highest sensitivity reported in the literature to date. This year a new ellipsoidal, flextensional interferometric hydrophone design was developed. The work on the system to measure the airborne acoustic noise in the space shuttle cargo bay during the launch phase has concentrated on a acoustic signal processing issues. The work on thermoacoustic energy transfer processes (Atchley, Garrett, Hofler, Larraza) has led to better understanding of the temperature gradient generated in thermoacoustic heat transport devices and experiments measuring the onset of thermally driven acoustics oscillations were made and seem to compare adequately with theory at low acoustic pressure amplitudes. At higher amplitudes, an onset of irregularities has been observed which will be further investigated. The work on the development of a thermoacoustic refrigerator for a test on a Shuttle Get Away Special G337, which is now scheduled for sometime in 1990 has continued and the refrigerator is now completed and has been tested and shown to maintain a 65° C temperature difference. The wave turbulence project is a new effort which will attempt to measure the spectral density of wind driven wave turbulence and the phase speed of the waves in order to test certain new theoretical models of steady state non-linear dynamical systems which are driven for off-equilibrium exhibiting chaotic behavior, (Garrett, Larraza, Denardo). In the transducer physics area (Wilson, Baker, Kuntsal) work continued on the investigation of the usefulness of the Delta-Z method for monitoring the sensitivity of in-service sonar transducers installed in domes which can be flooded and purged. The method has been developed into a state of the art computer-controlled measuring system and has been used on the AN/BQQ-6 sonar system on Trident submarines. The importance of this work lies in the ability to test large sonar system arrays on submarines in-situ avoiding the very costly dry-docking of the submarine for that purpose. The development of a compact apparatus to measure both the complex bulk modulus and the complex mass density of a fluid contained in a rigid porous solid has proceeded and different ways of measuring and extracting the complex effective mass have been compared. The Delta-Z method has been used for in-situ reciprocity calibration of sonar transducers and the sensitivity of the results to air-water temperature differences has been investigated. The compact Complex Immittance Measurement System which had been developed in previous years has been adapted to monitor the DT-605 hydrophone and has been used to monitor the performance of the spherical array of DT-574 hydrophones aboard the USS Ohio. The work on the application of the finite element computer codes ATILA and CHIFF to performance modeling of sonar arrays has continued with the adaptation of the code to model the DT-276A hydrophone.

ELECTRO-OPTICS/INFRARED SENSOR TECHNOLOGY

The work in this area is concentrated in the Naval Center for Infrared Technology (NACIT) at NPS which is led by Professor A. Cooper. Work continued in four areas: The NACIT Infrared Search and Target Designation Research (Cooper, Cleary, Crittenden, Lentz, Walker) seeks to establish a program of measurement of target and background scenes for analysis, development and of measurements of target background scenes for analysis, development, and validation of detection and background suppression algorithms and for evaluation of IRST technology. The program revolves around the NPS modified Advanced Demonstration Model IRSTD system supported by the Navy's AN/SAR-project office. This year new frame grabber technology has been installed to allow color coded raster scan display of selected sectors of the IRST 360 degree scan. A measurement exercise was carried out in which signature of calibration target, sky and land background scenes and aircraft targets at close range were analyzed and the detector channel compensation and Target enhancement features were shown to be effective for close targets. The Off-Board Countermeasures Program (Cooper, Crittenden, Milne, Rodeback, Lentz) is to carry out simulation analyses of performance and tactics for off-board decoys, development of hardware components for off-board devices and evaluation of passive ship defense techniques. A laser altimeter has been developed and tested from the Golden Gate Bridge at various sea states. Reflection measurements from the sea surface for nearly ocean like waves have shown that the probability distribution of the returned intensity differs from reported distributions in the literature. The Evaluation and Validation of FLIR Performance models (Cooper, Milne, Crittenden, Lentz, Walker) centered on the participation in experimental comparison observations involving overflights of FLIR carrying Naval aircraft, with code predications. An evaluation has been made of the sensitivity of the UFLIR code to variations in input and environmental parameters of the variability of the predicted ranges to the variation of radiosonde data in the operational area. The IR Sensor integrations into the AEGIS Weapons System project (Cooper, L. Wilson) which investigates the potential for integration of IR/Electro optical sensor data from the AN/SAR-8 into the AEGIS combat system and to evaluate the integration advantages, requirements, and implementation options has been continued. The current implementation of the Ship Combat System Simulation has been considered and evaluated as a model of generic multifunction array radar, for its appropriateness.

SPACE AND PLASMA PHYSICS

Research in this area spans a wide array of phenomena where plasma processes at the interface between man made devices and their respective environments have detrimental effects on the devices and where a thorough understanding of these processes is necessary before hardening strategies can be developed. Investigation of Plasma Heating Processes near the Plasmapause of the earth's magnetosphere was carried out by Olsen and Gnanalingam to determine the total density and the contributions of hot and cold ion populations, using existing satellite data. Most recently data taken by the SCATHA satellite near geosynchronous orbit were analyzed. Of direct relevance to satellite survival is the investigation of methods for Satellite Charge Control with on board electron and ion sources (Olsen, Gnanalingham). Data from earlier satellite experiments were analyzed. Data analysis from SPEAR I, a space power rocket experiment to determine the response of the rocket body to high voltages applied to a deployed boom have begun. Data from the ISEE satellite showed resonance plasma waves which were induced by an electron beam in the magnetospheric plasma which appear at the local plasma and upper hybrid resonance frequency. Preliminary design of a satellite based 10-Km tethered antenna system for VLF communication with submarines was done to study feasibility and the design work for a Hollow Cathode Rocket Experiment was completed and a proposal was submitted to NASA and work is expected to start in 1990. More down to earth Professor Schwirzke is investigating the unipolar arcing as a basic, potentially dangerous laser damage mechanism for the vulnerability to Laser Directed Energy Weapon Systems. These basic phenomena are of equal importance in plasma opening switches which are considered for application in high power short pulse Directed Energy Systems. This year energy and momentum coupling to conducting target materials were investigated, and the basic phenomenon of unipolar arcing catering has now been seen on the cathode surface of the high power vacuum diode of the NPS Flash X-ray facility. Finally as a new initiative Professor Cleary has begun the design building and testing of light weight ultraviolet spectrograph which is to be flown on a NASA Sounding rocket as test of principle of determining global ionospheric density profiles remotely from satellites by measuring certain UV emission line intensities. The experiment is to fly early 1990.

DIRECTED ENERGY BEAMS/RADIATION PHYSICS

Our Directed Energy Beam and Radiation Physics Group consisting of Professors Buskirk, Neighbours, and Maruyama is now concentrated on two large experimental facilities, the Linear Electron Accelerator, a high

energy (120 MeV), low current machine which has been working and producing results since 1965 and the new Flash X-Ray Pulse Power Facility, a low energy (1.8 MeV) high current (35 KA) Pulserad 112A machine, which is now operational. The FLX was put into operation and characterization of its performance has been completed and the complete suite of instrumentation has been installed, tested, and calibrated. In a first application of the new facility, the radiation hardness of high temperature superconductors was investigated. These new materials appear to be extremely radiation hard. The LINAC facility was used to investigate the effect of radiation on HgCdTe infrared detector which are important for space surveillance systems. The cooperative effort with the Los Alamos Lab on measurement of Electromagnetic signals from high current electron beams covering the range of Cerenkov, transition and electromagnetic pulse (EMP) signals from radio to x-ray frequencies was continued.

ENVIRONMENTAL PHYSICS

The research in this area falls in three categories: characterization of atmospheric optical turbulence, remote sensing of the lower earth thermosphere and investigation of flow and dispersion of hazardous gas plumes. The Optical Atmospheric Turbulence work is carried out by Professor Walters. The program provides continuous support the Air Force by providing measurements and assessment of atmospheric distortions for the Strategic Defense Initiative program using instrumentation for measuring modulation transfer function, isoplantic angle, acoustics sounder and rawinsonde systems to characterize the entire troposphere. These instrumentations were used in particular to characterize the atmosphere above the Pacific coastal mountain range to find sites with very low optical turbulence degradation. NPS research in this field has made it the principal source of data for decision processes directed by SDIO together with NASA, ONR, and NRL. A continuous program of such measurements was carried out to aid the optimal site selection for the new western US Naval Observatory. The long existing program of investigation of airflow and dispersion patterns of hazardous gaseous plumes has continued (Schacher, Kadada, Skupniewicz). These investigations involving meteorological field measurements and computer models have now resulted in the completion of the Vandenberg AFB Meteorological Plume Dispersion Handbook. A mesoscale prognostic windflow model and models of slope flow and seabreeze physics have been added to the arsenal of models.

INTERACTION OF SOUND AND OCEAN BUBBLES (FY 1989)

A.A. Atchley, Associate Professor of Physics
Sponsor: NPS Direct Funding/Naval Coastal Systems Center

OBJECTIVE: The main objective of this research is to conduct basic research in physical acoustics and its applications. The primary area of interest is thermoacoustic heat transport.

SUMMARY: Previously, the focus of this research was the investigation of the sizes of free bubbles rising in water. This year, the focus shifted to investigating the size and frequency response of acoustically levitated bubbles. Although there are quite a few theoretical predictions of the frequency response of bubbles, there is very little experimental information. The frequency response is an important quantity because it contains information about the damping of bubble oscillations. Particularly absent is knowledge concerning the damping of bubbles driven at frequencies well above their resonance frequency. Investigation of acoustically levitated bubbles through the dual frequency method may eventually yield such information. The technique was used to measure the growth rate of levitated bubbles, in order to show that the technique can yield the same information as other techniques. In addition, the frequency response of bubbles was obtained, something which other techniques cannot do as easily. No comparison to theoretical frequency response has been attempted. Theses comparisons require the use of sophisticated computer codes, not currently available at NPS.

CONFERENCE PRESENTATIONS: A.A. Atchley, R.A. Perron, and E.R. Lineberger, "Measurement of Bubble Properties Using a Multi-Frequency Sound Field," 117th Meeting of the Acoustical Society of American, NY, May 22-26, 1989. J. Acoust. Soc. Am. 85, Suppl. 1, S5(A), 1989.

R.A. Perron and A.A. Atchley, "Measurement of Bubble Properties Using a Multi-frequency Sound Field," Meeting of the Canadian Acoustical Society, Halifax, Novia Scotia, Canada, October, 1989.

THESIS DIRECTED: R.A. Perron, "Measurement of Bubble Properties Using a multi-frequency Sound Field," M.S., June 1989.

BASIC RESEARCH IN THERMOACOUSTIC HEAT TRANSPORT

A.A. Atchley, Associate Professor Physics
T.J. Hofler, Adjunct Professor of Physics
Sponsor: Office of Naval Research, Physics Division

OBJECTIVE: The main objective of this project is to conduct basic research in thermoacoustic heat transport. The primary areas for investigations are the investigation of thermoacoustic heat transport in very high amplitude acoustic standing waves and heat driven thermoacoustic prime movers.

SUMMARY: This project is a continuation of basic research in thermoacoustics carried out at NPS since FY88. The research described below was funded by this contact as well as by a reimbursable ONR contract having the same title. This summary is identical to that provided for the ONR project.

The primary area of activity has been the investigation of thermoacoustic primer movers, or sound sources. A thermoacoustic prime mover converts thermal energy into acoustic energy. The thermal energy is supplied to the prime mover by establishing a temperature gradient across a stack of plates situated in an acoustic resonator. A prime mover is said to reach onset when the applied temperature difference is sufficient to cause the prime mover to produce a sustained detectable level of sound. There are two regions of operation of prime movers - below and above onset. To date, the project has involved measuring the quality factor of a heat driven prime mover as a function of the temperature difference established across the prime mover stack. The work output of the prime mover can inferred from the quality factor. The major conclusions of this research are that the sound generation mechanism is relatively well understood below, but poorly understood above onset where high pressure amplitudes are involved.

PUBLICATIONS: A.A. Atchley, T.J. Hofler, M.L. Muzzerall, M.D. Kite, and Ao. C., Acoustically Generated Temperature Gradients in Short Plates," Accepted for publication in J. Acoust. Soc. Am.

CONFERENCE PRESENTATION: A.A. Atchley, T.J. Hoefler, and Ao, C., "The Measurement of Thermoacoustic Phenomena Using Thermoacoustics Couples," 118th Mtg. of the Acoustical Society of America, St. Louis, MO., November, 27-December 1, 1989. J. Acoust. Soc. Am. 86, Suppl. 1 S109(A), 1989.

THESIS DIRECTED: Lin, Hsiao Tseng, "Investigation of a Heat Driven Thermoacoustic Prime Mover," M.S., December 1989.

BASIC RESEARCH IN PHYSICAL ACOUSTICS AND ITS APPLICATIONS (FY1989)

A.A. Atchley, Associate Professor of Physics
S.L. Garrett, Professor of Physics
Sponsor: Office of Naval Research, Physics Division

OBJECTIVE: The main objective of this project is to conduct basic research in physical acoustics. The primary area of interest is thermoacoustics heat transport.

SUMMARY: The research conducted by Prof. Atchley under this contract was also funded by a supplemental reimbursable ONR contract entitled "Basic Research in Thermoacoustic Heat Transport." The following summary is identical that provided by the ONR contract.

One of the major areas of focus was the continuation of investigations of basic thermoacoustic phenomena using thermoacoustic couples (TACs). In short, this investigation consisted of measuring the temperature difference developed across a stack of short plates situated in an acoustic standing wave as a function of the acoustic pressure amplitude, frequency, type of gas, mean gas pressure, and position in the standing wave. The initial phase of these studies were completed during FY89. The major conclusions are: 1) predictions based on the theory of thermoacoustic heat transport agree relatively well, yet not completely, with the experimental results at low acoustic pressure amplitudes; 2) there are two regions of behavior at higher pressure amplitudes -- one characterized by a linear decrease in agreement between theory and experiment as the pressure amplitude increases and another at the highest pressure amplitudes characterized by the onset of irregularities in the data series. We plan to continue this type of measurements in the future in order to fully understand the results.

In addition to these TAC measurements, we began an investigation of thermoacoustic prime movers, or sound sources. The major conclusions of this research to date are that the sound generation mechanism is well understood when low pressure amplitudes are involved, but poorly understood when high pressure amplitudes are involved. This research is discussed more fully in the summary of the FY90 continuation of this project.

CONFERENCE PRESENTATION: T.J. Hofler, A.A. Atchley, and S.L. Garrett, "Simple Demonstration of a Thermoacoustic Sound Source," 117th Meeting of the Acoustical Society of America, Syracuse, NY, May 22-26, 1989, J. Acous. Soc. Am. 85, Suppl. 1, S112(A), 1989.

THESIS DIRECTED: Ao, Chia-ning, "The Measurement of Thermoacoustic Phenomena Using Thermoacoustic Couples," M.S., June 1989.

DEVELOPMENT OF A COMPACT APPARATUS TO MEASURE BOTH THE COMPLEX BULK MODULUS AND THE COMPLEX MASS DENSITY OF A FLUID CONTAINED IN A RIGID POROUS SOLID

S.R. Baker, Assistant Professor of Physics
O.B. Wilson, Professor of Physics
Sponsor: Naval Research Laboratory, Underwater Sound Reference Attachment

OBJECTIVE: Geoacoustic models of fluid-saturated sediment contain several parameters which depend upon the microscopic pore geometry, and which are very difficult to separate out from conventional sound speed and attenuation measurements. In particular, the parameters which are associated with the complex effective mass of the fluid within the pores are among the least well known. More easily obtained is the complex bulk modulus, or stiffness. The object of this research is to develop a compact apparatus with which both the complex effective mass and the complex bulk modulus may be obtained over a broad range of frequencies. This is a continuing project.

SUMMARY: Two methods are being investigated to accomplish the objective, both utilizing a small cylindrical chamber housing the fluid filled sample and capped on the ends with transducers. For his Masters thesis research in AY88, LT Steven Grant investigated a technique by which the complex effective mass is extracted from the effect it has on the input electrical impedance of a moving coil transducer. For his thesis research in AY89, LCDR Robert Mirick investigated an alternative technique by which the effective mass is extracted from acoustic pressure measurements within the chamber. His results indicate the latter technique is superior to the impedance method, and it is this technique which we will be further refining.

PUBLICATION: R.A. Mirick, S.R. Baker, and O.B. Wilson, "Apparatus to Determine the Complex Mass Density of a Viscous Fluid Contained in a Rigid Porous Solid from Acoustic Pressure Measurements," Journal of the Acoustical Society of America, 867, S!, S119, 1989.

CONFERENCE PRESENTATION: R.A. Mirick, S.R. Baker, and O.B. Wilson, "Apparatus to Determine the Complex Mass Density of a Viscous Fluid Contained in a Rigid Porous Solid from Acoustic Pressure Measurements," 118th Meeting of the Acoustical Society of America, St. Louis, MO, November 1989.

THESIS DIRECTED: LCDR R. Mirick, USN, "Apparatus to Determine the Complex Mass of a Viscous Fluid Contained in a Rigid Porous Solid from Acoustic Pressure Measurements," M.S., December 1989.

CONTINUED DEVELOPMENT OF THE DELTA-Z METHOD FOR IN-SITU RECIPROCITY CALIBRATION OF REVERSIBLE SONAR TRANSDUCERS

S.R. Baker, Assistant Professor of Physics
O.B. Wilson, Professor Physics
E. Kuntsal, Adjunct Research Professor of Physics
Sponsor: Naval Research Laboratory, Underwater Sound Reference Detachment

OBJECTIVE: The Delta-Z Method is a technique by which the sensitivity of a reversible underwater transducers may be obtained from the difference in its input electrical impedance in water and in air. The method has been successfully applied to a hollow piezoelectric sphere and to a single TR-317 transducers in the laboratory. The objective of this project is to develop the Delta-Z Method into a viable technique for the in-situ calibration of reversible sonar transducers installed in domes which can be flooded and purged. This is a continuing project.

SUMMARY: The focus of the project in 1989 was two-fold: 1) to extend previous work on a single transducer to an array of interacting transducers, and 2) to investigate the sensitivity of results of the Delta-Z Method to any temperature difference which may exist between water and air. For his Master's thesis research, LT Scott Tilden investigated the application of the Delta-Z Method to a 3x3 array of TR-317B transducers. The theory of the Delta-Z Method was extended to the case of a number of interacting transducers. A comparison of the results using the Delta-Z Method with those of a standard comparison calibration revealed that the finite-element model which was used to compute the various acoustical quantities required (e.g. radiation impedance) was not able to represent the acoustic field near the array in sufficient detail. Either a finer mesh(impractical) or a more sophisticated finite-element code, with quadratic interpolation functions, is required.

For his Master's thesis research, LT Chris Conklin investigated the effects of temperature variation on the results of the Delta-Z Method for the DT-574 hydrophone. He found that the difference in the input electrical impedance due to a small temperature difference could be comparable to the difference between water and air, and that the dominant cause was the variation with temperature of the dielectric constant of the piezoelectric ceramic. It appears this may correctable.

THESES DIRECTED: Scott Tilden, LT, USN, "Reciprocity Calibration of a 3x3 Array of TR-317B Transducers by the Delta-Z Method," M.S., September 1989.

Chris Conklin, LT, USCG, "The Temperature Dependence of the Properties of the DT-574 Hydrophone which Affect its Calibration by the Delta-Z Method," M.S., September 1989.

RADIATION AND RADIATION EFFECTS RESEARCH

F.R. Bushkirk, Professor of Physics
J.R. Neighbours, Professor of Physics
X.K. Maruayma, Professor of Physics
Sponsor: Theater Nuclear Warfare Program

OBJECTIVE: Research on production of radiation and effects of radiation on novel materials including high Tc superconductors.

SUMMARY: High temperature super-conductors were irradiated both at room temperature and at superconducting temperatures. These new materials appear to be extremely radiation hard. The transition temperature remained stable for both cases up to 100 Mrad of received dose.

THESIS DIRECTED: G.J. Wolfe, USA, "Effects of Large Doses of Energy Electrons on a $YBa2Cu_3O_{6\pm7}$ High Temperature Super Conductor," M.S., December 1989.

A SOUNDING ROCKET EXPERIMENT FOR REMOTE SENSING THE IONOSPHERIC E-AND F-LAYERS

D.D. Cleary, Assistant Professor of Physics
Sponsor: Office of Naval Research

OBJECTIVE: This is an ongoing research project whose objective is to develop a simple technique for measuring the ionospheric electron densities remotely from either rocket or satellite observation. The short term goal of this project is to design and fabricate a lightweight ultraviolet spectrograph capable of measuring ionospheric UV emissions. The long term objective is to use the data obtained from this and other experiments to infer electron densities with the aid of photochemical and radiative transfer models.

SUMMARY: The ultraviolet spectrograph has been built and has undergone initial calibration and alignment. This was done in preparation for an upcoming flight on NASA sounding rocket in March of 1990. In addition, existing UV spectra obtained from the Space Shuttle were analyzed as part of a student thesis project. This analysis produced several important results including the atmospheric temperature, nitric oxide density distribution, and the first observational determination of the Franck-Condon factors for the NO epsilon bonds.

PUBLICATIONS: C.A. Barth, D.E. Siskind, and D.D. Cleary, "The Effects of Soft Solar X-Rays on the Production of Nitric Oxide in The Thermosphere," Journal of Geophysical Research, Forthcoming.

D.D. Cleary, R.R. Meier, E.P. Gentieu, P.D. Feldman, and A.B. Christensen, "Analysis of Rocket Observations of OII 834: A Mission Near Solar Maximum," Journal of Geophysical Research, Forthcoming.

D.D. Cleary, R.P. McCoy, L.K. Harada, and S. Charkrabarti, "A Self-Consistent Analysis of the HeI (537 A,584 A) and OII (538 A 539 A, 834 A) EUV Airglow From STP 78-1 Satellite Measurements," Journal of Geophysical Research, Forthcoming.

THESES DIRECTED: J.L. Bosserman, LT, USN, "Analysis of Thermospheric Dayglow Spectra From the Spacelab I Shuttle Mission,," M.S., December 1989.

G.M. Danczyk, CPT, USA, "Identification of Thermospheric Dayglow Emissions for the MUSTANG Experiment," M.S., December 1989.

R. Campbell, LT, USN, "Development and Integration of the NPS Middle Ultraviolet Spectrograph with and Extreme Ultraviolet Spectrograph," M.S., December 1989.

ELECTRO-OPTICAL SIGNATURE MEASUREMENT FACILITY

A.W. Cooper, Professor of Physics
D.D. Cleary, Professor of Physics.
Sponsor: US Army Vulnerability Assessment Laboratory.

OBJECTIVE: To examine the technology and develop a methodology for characterizing the passive and active signatures of military devices. To develop techniques of vulnerability assessment.

SUMMARY: Electro-optic devices, both active and passive, are increasingly common in the military environment. Where laser systems, spot trackers, and passive sensors are found in the same locality, problems arise of detection, identification and susceptibility to damage. A study has already been made of laser devices and sensors actually or potentially in use. An estimate of a parameter set for characterization of a laser device has been made, and an examination undertaken of available technologies to measure these parameters. The three techniques currently in application or development for design of laser warning receivers have been surveyed, and other potential methods considered. An analysis has been made of the perturbation of the track signal of a generic reticle tracker due to a generic pulsed IR jamming signal. The reduction in susceptibility of an aircraft to the generic reticle tracked missile has been studied by simulation incorporating the jammed reticle output. The study will be extended to include jam susceptibility of sensors on the battlefield.

THESIS DIRECTED: Chia, Hock-Teck, Maj, Singapore Air Force, "Reducing the Susceptibility of Low Speed/Low Manoeuvrability Aircraft to Infrared Missile Kills," M.S., December 1989.

INFRARED SENSOR INTEGRATION INTO COMBAT SYSTEMS

A.W. Cooper, Professor of Physics
Sponsor: NSWC Dahlgren

OBJECTIVE: To evaluate the potential for integrating InfraRed sensor data into the AEGIS combat system, with particular reference to the AN/SAR-8 Infrared Search and Target Designation System. and compare the feasible modes of data fusion.

SUMMARY: Earlier phases of this project examined the characteristics of the SAR-8 output track data, and the architecture of the AEGIS system for feasible integration nodes. Merits of Sensor Level, Central Level, and Combined Sensor and Central Level Tracking have been considered. In the recent phase the functions and logical operation of the AN/SPY-1B(V)/D computer program has been examined and specific functional requirements extracted. The current implementation of the Ship Combat System Simulation (SCSS) has been considered as a model of a generic Multifunction Array Radar, and has been evaluated for appropriateness to model the AN/SPY-1b(V)/D MFAR. Proposed changes in structure and operation of the SCSS for more accurate modeling of the SPY-1B have been developed.

THESIS DIRECTED: T.A. Batzler, LT, USN, "Investigation into Simulating the AN/SPY-1B(V)/D Radar with the Ship Combat System Simulation (SCSS)," (SECRET Thesis); M.S., December 1989.

OFFBOARD COUNTERMEASURES PROGRAM SUPPORT.

A.W. Cooper, Professor of Physics
E.C. Crittenden, Jr., Distinguished Professor of Physics
E.A. Milne, Associate Professor of Physics
G.W. Rodeback, Associate Professor of Physics
Sponsor: Naval Sea Systems Command

OBJECTIVE: To investigate the reflection of a narrow beam laser altimeter output from the sea surface at normal incidence, and to develop a plan for testing the disposable altimeter in at-sea condition.

SUMMARY: In this continuing program a disposable laser altimeter suitable for off-board devices has been built. Performance evaluation requires detailed understanding of the reflection from the sea surface. Reflected laser intensity measurements have been made with a narrow beam (0.6x 0.4 deg.) GaAs laser for nearly ocean-like waves at vertical incidence from a platform on the Golden Gate bridge. Angular scans away from the vertical are used to characterize the sea state. A computer-based digital recording system was constructed to record the laser return signals for later processing in the laboratory. The probability distributions of the returned intensity have proved to be rather different from earlier literature reports. The distributions are often skewed from a normal distribution in the direction opposite to that for a log-normal distribution. The most probable magnitude of reflected intensity is nearly the maximum reflected intensity. Although the distribution also includes a peak at zero intensity, indicating that zero reflection occurs for an appreciable fraction of the time, the distribution is favorable for operation of laser altimeters because the high probability of large intensity reflections increases the useful range of a power-limited device.

PUBLICATIONS: E.C. Crittenden, Jr., G.W. Rodeback, A.W. Cooper, and C.M. Bourne, "Laser Altimeter for Use Over the Ocean," Naval Postgraduate School Report NPS-61-9-001, April 1989.

NACIT INFRARED SEARCH AND TARGET DESIGNATION RESEARCH

A.W. Cooper, Professor of Physics
W.J. Lentz, Research Associate of Physics
P.L. Walker, Research Physicist, Department of Physics
D.D. Cleary, Assistant Professor of Physics
E.C. Crittenden, Jr., Distinguished Professor of Physics
Sponsor: Naval Sea Systems Command PMS-421.

OBJECTIVE: To apply the NPS-Infrared Search and Target Designation system to record and analyze background scenes and target signatures for evaluation of target detection and background suppression algorithms, and for evaluation of IRST technology.

SUMMARY: An IRST system is designed to detect unresolved targets at the greatest feasible range, in the presence of sky (or sea) clutter. This is done using hardwired background suppression and thresholding. The NPS-IRST has been modified from the SAR-8 Advance Demonstration Model to allow recording of background data tapped off directly from the detectors. This is a continuing multiyear project, established and supported by the AN/SAR-8 Project Office. During the year frame grabber technology has been applied to obtain color coded raster scan display of selected sectors of the IRST 360 degree scan. Statistical parameters of the scene have been analyzed. For general application radiance distribution data should be independent of sensor details; various techniques of image compensation have been investigated. A measurement exercise was carried out in cooperation with Boeing Aerospace and Electronics Signal Processing Group to explore the use of the Boeing Burst Processor, a programmable data acquisition system developed for evaluation of sensor performance. Signatures of calibration targets, sky and land background scenes and aircraft targets at close range were analyzed. Detector channel compensation and deconvolution of instrument function were successfully applied. Target enhancement by spatial frequency filtering and frame-from-frame subtraction was shown to be effective for nearby targets.

PUBLICATIONS: A.W. Cooper, W.J. Lentz, E.D. Bloedel, L. Yee, R.R. Keever, M.A. Polehn, B.E. Northon, R.N. Murata; "Surface IRST Target and Background Measurements at Monterey," Proceedings of 1990 Meeting of IRIS Specialty Group on Targets, Backgrounds and Discrimination. Forthcoming.

E.C. Crittenden, Jr., and A.W. Cooper, "Modification, Testing, and Calibration of Infrared

Search and Target Designator Hardware Received from NSWC", NPS Technical Report NPS-61-89-011CR, May 1989.

CONFERENCE PRESENTATION: A.W. Cooper, W.J. Lentz, R.C. Engle, "Background Measurements using the NPS IRST System," SPIE OE/AEROSPACE SENSING '90, Orlando, FL, 16-20 April 1990.

THESES DIRECTED: M.L. Gribaudo, LT, USN; "Development of a System Model and Least Mean Square (LMS) Filter for the Naval Postgraduate School (NPS) Infrared Search and Target Designation System (IRSTD)," M.S., March 1989.

P.D. Lloyd, Capt, USMC, "The Design and Implementation of a Position Measuring System for a Remotely Operated Video Camera," M.S., June 1989.

R.C. Engel, LT, US Coast Guard, "A PC Based Imaging System for the Naval Postgraduate School Infrared Search and Target Designation (NPS-IRSTD) System," M.S., September 1989.

P.T. Fernan, LT USN, "Evaluation of a Potential Wave Division Multiplexer (WDM) for use in the IRSTD," M.S., December, 1989.

ENVIRONMENTAL EFFECTS ON IR SENSOR SYSTEMS

A.W. Cooper, Professor of Physics
E.A. Milne, Associate Professor of Physics.
E.C. Crittenden, Jr., Distinguished Professor of Physics.
W.J. Lentz , Research Associate, Department of Physics.
P.L. Walker, Research Physicist, Department of Physics.
Sponsor: Naval Environmental Prediction Research Facility.

OBJECTIVE: To validate and improve available Tactical Decision Aid codes for prediction of performance of operational FLIR devices by participation in experimental comparison of observations with code prediction and to evaluate improvements to existing codes.

SUMMARY This is a continuing multi-year program. In this phase a further measurement series of FLIR detection and recognition ranges was run with P-3 overflights of the RV Point Sur in conjunction with a meteorological/oceanographic cruise. The ship was additionally fitted with an array of thermal sensors. Comparison predictions of detection and recognition ranges will be made using the UFLIR TDA code utilizing both standard input and also experimental inputs. Related AGA infrared images were also taken of ship signature and sea and sky radiance. An evaluation has been made of the sensitivity of the UFLIR code to variations in input and environmental parameters, and also of the variability of the predicted ranges to the time and space variations of radiosonde data within the operational area. A comparative analysis has been made of the Air Force MKII TDA, currently being adapted to Navy use, with the UFLIR code currently in use in the Tactical Environmental Support System. An available data set of twenty-four radiosondes in a two week period was used with comparable inputs to the two systems.

CONFERENCE PRESENTATIONS: A.W. Cooper, M.G. Ridgeway, W.J. Lentz, P.L. Walker, "Experimental Validation of FLIR Tactical Decision Aid Programs," 1990 IRIS Specialty Group on Passive Sensors, Johns Hopkins Applied Physics Laboratory, Laurel, MD, March 13-15, 1990.

A.W. Cooper, M.G. Ridgeway, W.J. Lentz, P.L. Walker, "Modeling of Sea Surface Effects in FLIR Performance Codes," SPIE OE/AEROSPACE SENSING '90, Orlando, FL, April 16-20, 1990.

THESES DIRECTED R.G. Dodson, Capt, USMC, "A Comparison of FLIR Performance Prediction Models: UFLIR and MKII TDA," M.S., September 1989.

R. Reategui, LCDR, Peruvian Navy, "The Effect of Random Variation of Radiosonde Data on the Predicted FLIR Performance Calculated by the Program UFLR," M.S., September 1989.

Sefik Bayar, LTJG, Turkish Navy, "Statistical Analysis of Background IR Emission in the 3-5.6 and 8-14 Micrometer Region," M.S., September 1989.

FIBER-OPTIC REMOTE SENSING SYSTEMS

S.L. Garrett, Professor of Physics
Sponsor: SPAWAR

OBJECTIVE: This work started with the creation of the fiber-optical equivalent of a DIFAR sonar transducer which is entirely powered and interrogated by light in an optical fiber. This required the development of bi-directional and omnidirectional hydrophones which were interferometric and several fiber-optical magnetic heading sensor. During this period, the previous hydrophone designs have been adapted for hull-mounted sonar applications.

SUMMARY: This work is recognized as some of the best and most innovative in the field and has lead to invitations to present the results of our device designs and measurements in Navy labs (e.g., NRL - Washington, DC, ARL-Univ. Tex, NADC-Warminster, PA). industry (Raytheon-Submarine Signal Division, Sperry Marine, General Dynamics-Electric Boat Division, MacDonnell Douglas, Litton, GE and Others), and major universities including the NSF Center for Sensor Research at U.C. Berkeley. In just the last five years, the work has resulted in eight patents (three issued, five pending), six journal publications, five long papers in proceedings, and ten conference presentations with published abstracts. Professor Garrett received the first Carl E. and Jessie W. Menneken Faculty Research Award for Excellence in Scientific Research for this program of fiber-optic sensor research and development and one of his students (LT Newmaster) received the Mewborn Award. Work during this reporting period has concentrated on the development of novel opto-electronic interferometric demodulation techniques and a flexural plate, fiber-optic, interferometric, acceleration canceling, omnidirectional hydrophone. An accelerometer based on the same design was also completed that should be suitable for vibration monitoring on Naval platforms and in industrial applications. A new ellipsoidal, flextensional, interferometric hydrophone design was developed in collaboration with Professor D. Danielson (Math) and a patent disclosure was filed.

THESIS DIRECTED: J.A. Flayharty, LT, USN and B.M. Fitzgerald, LT, USN, "Design and Fabrication of a Fiber Optic Acceleration Canceling Hydrophone," M.S., September 1989.

SPACE SHUTTLE CARGO BAY VIBROACOUSTICS EXPERIMENTS

S.L. Garret, Professor of Physics
O.B. Wilson, Professor of Physics
R. Panholzer, Professor of Computer and Electrical Engineering
Sponsor: Director of Naval Space (OPNAV-0943)

OBJECTIVE: This is an experiment which will "fly" on the Space Shuttle as a Get Away Special (NASAG-313) to measure the acoustics (airborne) noise in the cargo bay from launch until the vehicle is exoatmospheric. Professor Garrett designed the acoustical portion of the experiment (microphones, speakers, pre-amplifiers, etc.) in collaboration with his two other co-principal investigators; Professor O.B. Wilson who designed the microphone isolators and Professor R. Panholzer who was responsible for the development of the bubble memory data recorder and other electrical subsystems.

SUMMARY: During this period, Professor Garrett's efforts were concentrated on another Get Away Special project, the Space Thermo-Acoustic Refrigerator (NASA G-337). Because of the importance of G-337 (it was selected as the top priority DoD small payload by the Tri-services Board evaluation process) much of G-313 was put on hold. Since many subsystems used by G-337 and G-313 are shared (microprocessor controller, power supply, bubble memory data recorded, etc.) the distinction between these two projects is blurred. Most of the work that could be directly identified with G-313 was done in the area of microprocessor experimental control and the design of the acoustics, transduction, and electronics for auxiliary power unit (APU) "turn-on" detection algorithm. This work is documented in the thesis of LT C.B. Cameron, USN, entitled "Control of an Experiment to Measure Acoustic Noise in the Space Shuttle," which was completed in June 1989. Professor Garrett's contribution to that work was mostly in the area of the matched filter analog electronic design of the APU turn-on detection algorithm.

THESIS DIRECTED: C.B. Cameron, LT, USN, "Control of an Experiment to Measure Acoustic Noise in the Space Shuttle," M.S. in Electrical Engineering and Electrical Engineer, June 1989.

WAVE TURBULENCE AND THE SEARCH FOR CLASSICAL SECOND SOUND

S.L. Garrett, Professor of Physics
A. Larraza, Adjunct Research Professor of Physics
Sponsor: Office of Naval Research

OBJECTIVE: For four-hundred years, physicists have concentrated on understanding the equilibrium state and small deviations from that state. In the past decade, physicists have finally attempted to characterize processes, such as turbulence, which exist in systems which are "open" and therefore can be in a steady state which is far off-equilibrium. Much of this recent work in non-linear dynamics and "chaos" has been theoretical and the "tests" have been numerical simulations. One of the difficulties in the characterization of such systems in real continuous matter is that the temporal and spatial variations are uncoupled, hence the systems of equations are not necessarily closed. For the case of acoustic turbulence the phase speed couples the two scales in the problem and the equations can be solved. A paper entitled "Dispersion Relations for Gravity Waves in Deep Fluid: Second Sound in a Stormy Sea," which describes the theory, has been accepted for publication in Physical Review A.

SUMMARY: During the period covered by this report, we have identified wind-driven, deep water gravity waves as an experimentally tractable system in which a test of the crucial predictions of the theory can be made in a reasonable time at modest cost. To do so, we have designed, fabricated and are currently testing a capacitive, dual-channel wave staff that is extremely linear and capable of measuring the spectral density of the wind-driven wave turbulence and the phase speed of the waves. We have also designed and ordered a wave generator driven by an hydraulic servo-control system.

SPACE THERMOACOUSTIC REFRIGERATOR

S.L. Garrett, Professor of Physics
T.J. Hofler, Adjunct Professor of Physics
Sponsor: Naval Research Laboratory

OBJECTIVE: To design, fabricate, and test, a cryocooler suitable for flight as a Get Away Special on the Space Shuttle which uses sound to pump heat.

SUMMARY: The Space Thermo-Acoustic Refrigerator (STAR) is an experiment which will "fly" on the Space Shuttle as a Get Away Special (NASA G-337) sometime 1990. It is an entirely self-contained system including the thermoacoustic refrigerator (electrodynamic driver, acoustic resonator, thermodynamic "stack," gas handling and vacuum can) and its support electronics (microprocessor, bubble memory data recorder, resonance frequency and amplitude feedback controller, multiplexed measurement systems and A-to-D converters for 21 different sensors, batteries and power distribution system, and pulse-width modulated heat load).

During this period the refrigerator was completed and produced a temperature difference of 65°C with a 10 bar He/Ar working fluid and a pressure amplitude of P_o/P_m = 3%. Also, the "protoboard" versions of the electronic subsystems for autonomous operation while on orbit was completed.

CONFERENCE PRESENTATIONS: T. Hofler and M. Suzalla, "The Dependence of Experimental Performance of a Thermoacoustic Refrigerator on Geometry," J. Acoust. Soc. Am. 85(1), S47, 1989.

S.L. Garrett, T. Hofler, M. Fitzpatrick, M.P. Suzalla, R. Volkert, and D. Harris, "Thermoacoustic Refrigerator for Space Applications," J. Acoust. Soc. Am. 85(1), S48, 1989.

THESES DIRECTED: D.A. Harris, CAPT, CF, and R.E. Volkert, LT, USN, "Design and Calibration of an Electrodynamic Driver for the Space Thermoacoustic Refrigerator," M.S., June and December, 1989.

R.B. Byrnes, CAPT, USA, "Electronics of Autonomous Measurement and Control of Thermoacoustic Refrigerator in Space," M.S., December 1989.

FLASH X-RAY FACILITY, PART II

X.K. Maruyama, Professor of Physics
Sponsor: NPS Research Council

OBJECTIVE: To install, make operational and instrument the Pulserad 112A flash X-ray machine at Bldg. 216 of the Naval Postgraduate School.

SUMMARY: The two year project to make fully operational the Pulserad 112A flash X-ray laboratory has been completed. The laboratory has been refurbished for use; the Pulserad 112S machine is now operational; and instrumentation has been obtained. The FXR has been characterized and safety features have been incorporated. A RASO inspection has been conducted and the FXR is fully capable for use. The FXR is an interdisciplinary tool for physical phenomenon investigation.

PUBLICATIONS: H.B. Luna, X.K. Maruyama, N.J. Colella, J.S. Hobbs, R.S. Hornady, B. Kulke, and J.V. Palomar, "Bremsstrahlung Radiation Effects in Rare Earth Permanent Magnets," Nuclear Instruments and Methods, A458, 1989.

CONFERENCE PRESENTATIONS: X.K. Maruyama, and F. Schwirzke, "Laser Breakdown and High Voltage Induced Breakdown Metal Surfaces," 9th International Workshop on Laser Interaction and Related Plasma Phenomena, Monterey, CA, 06-10 November 1989.

F. Schwirzke, X.K. Maruyama, and S.A. Minnick, "Onset of Breakdown in a Vacuum Diode," 31st Annual Meeting of the Division of Plasma Physics of the American Physical Society, Los Angeles, CA, October 1989.

THESES DIRECTED: R.S. Pietruska, LT, USN, "Operation and Characteristics of the Flash X-Ray Generator," M.S., June 1989.

R.J. Phillips, CPT, USA, "ITS Cerenkov Radiation," M.S., December 1989.

J.R. Kim, MAJ, ROK Army, "Dose Analysis of the Model 112A Pulserad X-Ray Generator by ITS/CYLTRAN," M.S., December 1989.

S.A. Minnick, "Unipolar Arching on the Cathode Surface of a High Voltage Diode," M.S., December 1989.

RADIATION EFFECTS IN SEMICONDUCTOR DETECTORS

X.K. Maruyama, Professor of Physics
Sponsor: Weapons Laboratory

OBJECTIVE: Measurement of radiation damage effects on infrared semiconductor detectors.

SUMMARY: Dose dependent response of HgCdTe infrared detectors were measured. These devices are for space surveillance systems Applications. The NPS linear electron accelerator was used at the radiation source. This project is to characterize specific devices for classified applications.

MEASUREMENT OF EM RADIATION FROM HIGH CURRENT ELECTRON BEAMS

J.R. Neighbours, Professor of Physics
F.R. Buskirk, Professor of Physics
X.K. Maruyama, Professor of Physics
Sponsor: Space and Naval Warfare Systems Command

OBJECTIVE: Research on electromagnetic radiation emitted from high current electron beams. Measurements of signatures of electron beam traversing air and from the accelerator air interface will be made to study near and far field effects.

SUMMARY: Electron beam signatures were measured from charged particle beams. Cerenkov, transition and electromagnetic pulse radiation covering spectral ranges from radio to x-ray were measured.

PUBLICATIONS: M.A. Piestrup, D. Boyer, C.I. Pincus, Q. Li, M.J. Moran, J.C. Bergstrom, H.S. Caplan, R.M. Silzer, D.M. Skopik, X.K. Maruyama, F.R. Buskirk, J.R. Neighbours, G.B. Rothbart, "Detection of Coherent X-Ray Transition and Its Application to Beam Diagnostics," Nuclear Instruments and Methods, B40/41, 965, 1989.

J.R. Neighbours, F.R. Buskirk, X.K. Maruyama, "Frequency Content of Coherent Cerenkov Radiation," NPS Technical Report, NPS-61-90-001, November 1989.

J.R. Neighbours, F.R. Buskirk, X.K. Maruyama, D.D. Snyder, R. Lally, and H. Nye, "Wide Band RF Measurements of the Signals from an Electron Beam," Proceedings of the DARPA/SDIO/Services Annual Charge Particle Beam Theory, 1989. (Classified)

CONFERENCE PRESENTATIONS: J.R. Neighbours, F.R. Buskirk, X.K. Maruyama, D.D. Snyder, R. Lally, and H. Nye, "Wide Band Measurements of the Electron Beam," DARPA/SDIO/Services Annual Charge Particle Beam Review, Monterey, CA, 18-21 September 1989.

ELECTRON BEAM GENERATED PLASMA WAVES

R.C. Olsen, Associate Professor of Physics
Sponsor: National Aeronautics and Space Administration

OBJECTIVE: Analyze plasma wave data taken during electron gun experiments on the ISEE 1 satellite in June-July 1987. Search for features in the data which indicate beam-plasma interactions induced by the electron beam.

SUMMARY: Analysis of the plasma wave data showed that resonant interactions were induced when the 40 eV electron beam was emitted into the hot, tenuous magnetosphere plasma. Strong features were seen at the local plasma frequency (or upper hybrid resonance frequency). There was a persistent feature which appears to results from interactions between the beam and local photo-electron cloud.

CONFERENCE PRESENTATIONS: R.R. Anderson, R.C. Olsen, and F. S. Mozer, "Plasma Wave Observations during Electron Gun Operations on ISEE 1," Presented at the American Geophysical Union Meeting in San Fran., CA, December 1989.

R.C. Olsen, "Current Limiting Mechanisms in Electron and Ion Beam Experiments," Presented at the 1st workshop on Current Collection from Space Plasmas, Huntsville, AL, 24-25 April 1989, proceedings in press.

SPACE POWER EXPERIMENT ABOARD ROCKET (SPEAR)

R.C. Olsen, Associate Professor of Physics
Sponsor: Defense Nuclear Agency

OBJECTIVE: Analyze data taken by SPEAR I to determine the potential response of the rocket body to a high voltage pattern applied to a deployed boom set. A secondary objective has been to support the preflight tests and launch of SPEAR II.

SUMMARY: Few results are available. Data analysis for SPEAR I has only just begun, and SPEAR II chambers tests have been delayed.

PLASMA HEATING AT THE PLASMAPAUSE

R.C. Olsen, Associate Professor of Physics
Sponsor: Office of Naval Research

OBJECTIVE: Analyze particle field, and wave data from satellites orbiting the earth near the magnetic equator, near the plasmapause. The thrust of the analysis is to determine the characteristics of the cold and hot plasmas which can lead to interchange of energy - e.g. heating.

SUMMARY: This work has been part of an ongoing study. Data analysis during the past year has been focused on data taken near geosynchronous orbit, from the SCATHA satellite.

VLF SPACE TRANSMITTER (SUBCOM)

R.C. Olsen, Associate Professor of Physics
Sponsor: NAVSEA

OBJECTIVE: Design a satellite based, 10-km tethered antenna system for VLF communications with submarines.

SUMMARY: Preliminary design work indicated that this technique is viable, but does not present sufficient advantages over current or other projected techniques to stimulate funding for an experiment.

PUBLICATIONS: R.C. Olsen and G.C. Thompson, "VLF Space Transmitters, Tehters in Space - Towards Flight," AIAA, Washington, DC, p. 274-279, 1989.

CONFERENCE PRESENTATIONS: R.C. Olsen and G.C. Thompson, "VLF Space Transmitters," Presented at the 3rd International Conference on Tethers in Space - Towards Flight, San Fran., CA, 17-19 May 1989.

HOLLOW CATHODE ROCKET EXPERIMENT (HOCAT)

R.C. Olsen, Associate Professor of Physics
Sponsor: Office of Naval Research

OBJECTIVE: Design a sounding rocket experiment to determine the physical processes which control current collection in the ionosphere. The processes of interest are those which occur when active plasma sources are operated - e.g. hollow cathode gas discharge devices.

SUMMARY: The design work was completed. A proposal was submitted to NASA for funding in FY1990. Subsequently, the NASA Office of Space Science and Applications determined that there would be no further funding for any active (space) plasma experiments. It appears, however, that NASA/Lewis Research Center will fund initial construction of the instrumentation, beginning in early 1990.

CONFERENCE PRESENTATION: R.C. Olsen, "A Hollow Cathode Rocket Experiment," presented at the AIAA 27th Aerospace Sciences Meeting, Reno, NV, 9-12 January 1989.

THESES DIRECTED: Young-chul Park, "Hollow Cathode Plasma Source Characteristics," M.S., December 1989.

Hwang-Jin Han, "Physical Processes in Hollow Cathode Discharge," M.S., December 1989.

EXTENDED DOMAIN, 3-DIMENSIONAL HAZARD ASSESSMENT OF ROCKET PLUMES AND GROUND SOURCES, VANDENBERG APPLICATIONS

G.E. Schacher, Dean of Faculty and Graduate Studies
R.F. Kamada, Adjunct Research Professor of Physics
C.E. Skupniewicz, Physical Scientist
Sponsor: Air Force Space Division

OBJECTIVE: Improve Vandenberg AFB launch exhaust and ground source plume release dispersion prediction ability.

SUMMARY: A field study showed that afternoon westerlies can advect very large plumes from Vandenberg's Hypergolic Fuel Storage Facility to Lompoc, CA. We are confirming details using a mesoscale prognostic windflow model from Colorado State U. We compared data from the Mt. Iron field study with two diagnostic dispersion models. Slope flow and seabreeze physics is being added to the LINCOM diagnostic flow model. We have completed a data analysis of the Vandenberg Boundary Layer Survey study. It shows that plume fumigation can occur by increased entrainment and convective mixing along the coastal stratus front, endemic to Vandenberg. Inversion height algorithms were developed and tested against the Survey data.

PUBLICATIONS: C.E. Skupniewicz, R.F. Kamada, and G.E. Schacher, "Turbulence Measurements Over Complex Terrain," Bound. Layer Meteorol., 58, pp. 109-128, 1989.

R.F. Kamada, "A Preliminary Review of Flow Models Considered for Use at Vandenberg AFB," NPS61-89-007, Plenum, New York, 1989.

R.F. Kamada, C.E. Skupniewicz, J.W. Glendening, G.E. Schacher, T. Mikkelsen, S.T. Nielsen, I. Troen, S. Larsen, and E.S. Takle, "Vandenberg Meteorology and Plume Dispersion Handbook for Boundary Layers Releases, NPS61-89-004, P 450, January 1989.

CONFERENCE PRESENTATIONS: S.T. Nielsen, T. Mikkelsen, S.E. Larsen, I. Troen, A.F. deBaas, R.F. Kamada, C.E. Skupniewicz, and G.E. Schacher, "Model for Accidental Releases in Complex Terrain," Proc. 17th NATO/CCMS ITM, Cambridge (UK), Plenum, New York, 1989.

DISCHARGE PHYSICS AND PLASMA SURFACE EFFECTS OF PLASMA OPENING SWITCHES

F.R. Schwirzke, Professor of Physics
Sponsor: Naval Research laboratory

OBJECTIVE: Investigate breakdown and plasma formation on electrodes as fundamental processes in pulsed power technology.

SUMMARY: The initial "explosive" plasma formation on the surface of a cathode of a vacuum diode and many other discharges is highly non-uniform. Micron size cathode spots from within ns. Laser produced unipolar arcs, UPA, ignite and burn on a ns time scale. Similar UPA craters have now been observed on the cathode surface of a pulsed vacuum diode. Field emitted electrons ionize desorbed neutrals above an emitting spot. Plasma pressure gradients then naturally lead to electric fields which ignite and drive the UPA. Power dissipation for an UPA is considerable larger than for field emitted or space charge limited current flow. The high current density of an UPA provides explosive plasma formation. Unipolar arcing represents a fundamental form of discharge which contributes to breakdown and formation of cathode spots in a unique way.

PUBLICATIONS: F. Schwirzke, "Plasma Formation on Surfaces by Microexplosions and Unipolar Arching," Workshop on Transient Induced Insulator Flashover in Vacuum, Lawrence Livermore National Laboratory, Conference 8808171, Section 10, 1989.

F. Schwirzke, "Magnetic Field Generation in Shock Waves Caused by Plasma Streamers," Bull. Am. Phy. Soc., 34, 1276, April 1989.

F. Schwirzke, X.K. Maruyama, and S.A. Minneck, "Onset of Breakdown in a Vacuum Diode," Bull. Am. Phys. soc., 34, 2103, October 1989.

F. Schwirzke, "Formation of Cathode Spots by Unipolar Arching," 42nd Annual Gaseous Electronics Conference, 17-20 October 1989.

CONFERENCE PRESENTATIONS: F.R. Schwirzke, X.K. Maruyama, and S.A. Minneck, "Onset of Breakdown in a Vacuum Diode," 31st Annual Meeting of Division of Plasma Physics, 13-17 November 1989.

F. Schwirzke, "Formation of Cathode Spots by Unipolar Arching," 42nd annual Gaseous Electronics Conference, Palo Alto, CA, 17-20 October 1989.

F. Schwirzke, "Laser Induced Breakdown and High Voltage Induced Breakdown on Metal Surfaces," 9th International Workshop on Laser Interactions and Related Plasma Phenomena, Monterey, CA, 6-10 November 1989.

THESIS DIRECTED: S.A. Minneck, LT, USN, "Unipolar Arching on the Cathode Surface of a High Voltage Diode," M.S., December 1989.

UNIPOLAR ARCHING, A BASIC LASER DAMAGE MECHANISM

F.R. Schwirzke, Professor of Physics
Sponsor: Office of Naval Research

OBJECTIVE: Investigate the discharge physics of laser induced breakdown and unipolar arcing on conducting and non-conducting surfaces.

SUMMARY: Laser beams interact with surfaces by a variety of thermal impulse, and electrical effects. Unipolar arcing is the primary electrical plasma-surface interaction process once breakdown occurs. Without any external voltage applied, many electrical micro-arcs burn between the surface and the laser heated plasma, driven by local variations of the sheath potential with the surface acting at both the cathode and anode. Energy and momentum coupling to conducting target materials has been investigated to determine what effect unipolar arcing has on the coupling process.

CONFERENCE PRESENTATION: F. Schwirzke, "Laser Induced Breakdown and High Voltage Induced Breakdown on Metal Surfaces," 9th Interantional Workshop on Laser Interaction and Related Plasma Phenomena, Monterey, CA, 6-10 November 1989.

THESES DIRECTED: M.V. Henson, LT. USN, "Generation of Electromagnetic Radiation due to Laser Induced Breakdown and Unipolar Arcing," M.S., September 1989.

R.K. Downs, LT, USN, "Surface Dynamics of Unipolar Arcing," M.S., December 1989.

Duck-Sang Youn, LCDR, Korean Navy, "Measurements on Laser Produced Plasma Using Faraday Cups," M.S., December 1989.

REMOTE ATMOSPHERIC OPTICAL TURBULENCE MEASUREMENTS

D.L. Walters, Associate Professor of Physics
Sponsor: Classified

OBJECTIVE: Investigate the magnitude and source of optical turbulence that degrades image propagation.

SUMMARY: The operation of ground based optical target acquisition and surveillance systems depend on the amount of optical turbulence within the atmosphere. Measurements of the diurnal and annual variations of these effects as well as a determination of the source of the phenomena are needed. A combination of optical isoplantic angle and atmospheric coherence length measurements and acoustic sounder data are collected as well as the development of research grade meteorological balloon sounding techniques. All of the techniques and equipment needed for these measurements are developed and implemented at NPS with student participation.

All aspects of the results of this program are classified with a restricted need to know. Results of this program are integrated into other research efforts in a transparent fashion when possible.

THESIS DIRECTED: G.M. Tirrell-Vaucher, "Correlation of Atmospheric Optical Turbulence and Meteorological Measurements," M.S., June 1989.

OPTIMAL ATMOSPHERIC OPTICAL SITE MEASUREMENTS

D.L. Walters, Associate Professor of Physics
Sponsor: Naval Research Laboratory

OBJECTIVE: Investigate the atmospheric optical phenomena leading to optimal sites for large baseline optical interferometers.

SUMMARY: The atmosphere produces a optical turbulence that degrade image propagation. Large 100 m baseline Michaelson interferometer optical arrays, similar to those used in radio astronomy are in the development stage. The performance of these system and speckle imaging systems depends on the atmospheric coherence length r_o and the aperture diameter D by $(D/r_o)^{\frac{5}{3}}$. Finding a site with minimum optical turbulence is essential to the development of large imaging systems. Based upon NPS measurements collected during 1986-1987, the Pacific Coastal mountain ranges can be exceptional. We have found that there are primarily three regions of atmospheric layers that dominate the integrated turbulence along the atmospheric path. The 10-50 m surface layers, the boundary layer associated with the surrounding terrain, and the tropopause. The temperature inversion and the windspeed across these layers determines whether they are turbulent. The interaction of each of these independent layers determines optimal sites. Optimal conditions occur only when these region are quiescent, simultaneously.

CONFERENCE PRESENTATIONS: D. Walters, "Optimal Site Selection," U.S. Naval Observatory, 4 Feb. 1989.

THESES DIRECTED: E.A. Ugorcak, LT, USN, "Numerical Simulation of Optical Turbulence Utilizing Two-Dimensional Gaussian Phase Screens," M.S., March 1989.

J.L. Turner, LT, USN, "A Simulation of Optical Propagation Through Atmospheric Turbulence Using Two-Dimensional Fourier Transform Techniques," M.S., June 1989.

MODELING OF SONAR TRANSDUCERS AND ACOUSTIC FIELDS USING FINITE-ELEMENT METHODS

O.B. Wilson, Professor Physics
O.B. Baker, Assistant Professor of Physics
E. Kuntsal, Adjunct Research Professor of Physics
Sponsor: Naval Research Laboratory,
Underwater Sound Reference Detachment

OBJECTIVE: The objective of this project is to apply finite element computer codes, primarily ATILA and CHIEF, to the performance modeling of sonar transducers and arrays. This is a continuing project.

SUMMARY: For his Master's thesis research, LT Michael Brown developed the method by which the ATILA finite-element code can be used to compute the standard two-port network parameters of a single degree-of-freedom piezoelectric transducers. A follow-on student is extending his work to a multiple-degree-of-freedom transducers. For his Master's thesis research, LT Ralph Ward adapted a previously-developed finite-element model of the DT-276 hydrophone to the DT-276A, a redesign which features a different construction where the cable attaches to the hydrophone. He validated the models of the old and new designs against experimental electrical impedance measurements, and identified the effect of the redesign on various performance parameters.

THESIS DIRECTED: LT Michael Brown, USN, "Calculation of the Two-Port Network Parameters for the DT-574 Using the ATILA Finite-Element Code," M.S., December 1989.

LT Ralph Ward, USN, "Finite Element Analysis of the DT-276 Hydrophone," M.S., December 1989.

1989
NAVAL POSTGRADUATE SCHOOL PUBLICATIONS

DEPARTMENT OF AERONAUTICS AND ASTRONAUTICS

CONFERENCE PRESENTATIONS

Agrawal, B.N.
Analytical prediction of nutation time constant for spinning spacecraft with partially filled tanks
Proceedings of the 7th VPI and SU/AIAA Symposium on Dynamics and Control of Flexible Large Structures, Blacksburg, VA, May 8-10, 1989.

Ball, R.E.
Combat survivability: Challenges and opportunities
Presented at the ADPA Symposium, September 13, 1989.

Ball, R.E.
Survivability design of advanced military aircraft
Presented at the AIAA Aerospace Engineering Conference and Show, Los Angeles, CA, February 14, 1989.

Ball, R.E.
An introduction to aircraft combat survivability
Presented at the 6th U.S. Army IP/SIP Conference, Mesa Arizona, March 2, 1989.

Carr, L.W., Platzer, M.F., Chandrasekhara, M.S., Ekaterinaris, J.A.
Experimental and compuational studies of dynamic stall
Presented at the 4th Symposium on Numerical and Physical Aspects of Aerodynamic Flows, Long Beach, CA, January 1989.

Chandrasekhara, M.S.
Compressiblity effects on dynamic stall
Presented at the City University Center for Aeronautics, London, U.K., September 1989.

Chandrasekhara, M.S., Carr, L.W.
Design and development of a facility for compressible dynamic studies of a rapidly pitching airfoil
Presented at the 13th International Conference on Instrumentation of Aerospace Simulation Facilities, Goettingen, West Germany, September 1989.

Gorman, M.R.
AE from transverse matrix cracking
NASA Langley Research Center, Drexel University, October 12, 1989.

Gorman, M.R., Ziola, S.M., Koury, J.L.
Acoustical detection of transverse cracking in a crossply composite
Proceedings of the 3rd International Symposium on Acoustic Emission from Composite Materials (AECM-3), Paris, France, July 17-21, 1989.

Healey, J.V.
Interface research at NPS
Presented at the Aerodynamic Ship Interface Conference, Washington, DC, November 1989.

Healey, J.V.
Ship airwakes
Presented at the Naval Engineers/Architects at the American society of Navy Engineers ASNE Conference, Washington, DC, May 1989.

Hebbar, S.K., Chandrasekhara, M.S., Chlebanowski, J.S.
Flow visualization by laser sheet
Presented at the 4th Asian Congress of Fluid Mechanics, Hong Kong, August 1989.

Miley, S.J., Howard, R.M.
Effects of propeller slipstream on wing laminar boundary layer
Proceedings of the Australian Aeronautical Conference, Melbuorne, Australia, pp. 362-367, October 1989.

Schmidt, L.V.
Ship roll stabilization in the U.S. Navy
Presented at the Annual American Society of Naval Engineers (ASNE) National Conference, Washington, DC, May 1989.

Schmidt, L.V.
Wind rock due inertial coupling
Presented at the Symposium on Fluid Dynamics, California Institute of Technology, Pasadena, CA, August 1989.

Shreeve, R.P.
Supersonic-hypersonic jet-interaction experiments at BSRL circa 1970
Presented at the JANNAF Workshop on Fuel-Air Mixing in Supersonic Combustors, Cleveland, OH, May 22, 1989.

Shreeve, R.P., Elazar, Y.
Viscous flow in a controlled diffusion compressor casdade with increasing incidence
Presented at the 33rd International Gas Turbine and Aeroengine Congress and Exhibition, Toronto, June 5-8, 1989.

PUBLISHED PAPERS

Agrawal, B.N.
Effects of flexibility one attitude stability of spinning spacecraft
Proceedings of the 12th ASME Biennial Conference on Mechanical Vibration and Noise, vol. no. H0508A, Montereal, September 17-21, 1989.

Agrawal, B.N., Khyam, D., Laurenson, R.
Further development and evaluation of a simpler approach to update technology, spacecraft launch loads
1989 ASME Winter Annual Meeting, Paper no. B-1285, December 1989.

Badrinarayanan, M.A., Platzer, M.F.
Excitation of plane jet by twin-vane oscillator
27th Aerospace Sciences Meeting, Paper no. AIAA 89-0663, January 1989.

Baitis, A.E., Schmidt, L.V.
Ship roll stabilization in the U.S. Navy
Naval Engineers Journal, 101, pp. 43-53, May 1989.

Boelcs, A., Fransson, T.H., Platzer, M.F.
Numerical simulation of inviscid transonic flow through nozzles with fluctuating back pressure
ASME Journal of Turbomachinery, vol. 111, pp. 169-180, April 1989.

Carr, L.W., Chandrasekhara, M.S.
Design and development of a compressible stall facility
AIAA Paper no. 89-0647, Presented at the AIAA 27th Aerospace Sciences Meeting, Reno, NV, January 1989.

Cebeci, T., Platzer, M.F.
A general method for unsteady heat transfer on turbine blades
NASA CR-4206, January 1989.

Chandrasekhara, M.S., Carr, L.W.
Flow Visualization studies of the mach number effects on the dynamic stall of oscillating airfoils
AIAA Paper no. 89-0023, Presented at the AIAA 27th Aerospace Sciences Meeting, Reno, NV, January 1989.

Driver, D.M., Hebbar, S.K.
Three-dimensional shear-driven boundary-layer flow with streamwise adverse pressure gradient
AIAA Journal, vol. 27, pp. 1689-1697, December 1989.

Howard, R.M., Miley, S.J.
Time-dependent boundary layer response in a propeller slipstream
Journal of Aircraft, vol. 26, no. 9, pp. 863-869, September 1989.

Howard, R.M., Rabang, M.P., Roane, D.P.
Aerodynamic effects of a turbulent flowfield on a vertically launched missile
Journal of Spacecraft and Rockets, vol. 26, no. 6, pp. 445-451, November/December 1989.

Howard, R.M., Rabang, M.P., Roane, D.P.
Aerodynamic effects of a turbulent flowfield on a vertically launched missile
AIAA Paper 89-0329, AIAA 27th Aerospace Sciences Meeting, Reno, NV, January 1989.

Howard, R.M., Renoud, R.W.
Wing boundary layer response to an unsteady turbulent flowfield
AIAA Paper 89-2226, Proceedings of the AIAA 7th Applied Aerodynamics Conference, pp. 637-644, Seattle WA, July 1989.

Johns, M.K., Healey, J.V.
The airwake of a DD-963 class destroyer
American Society of Naval Engineers' Journal, pp. 36-42, May 1989.

Ramaprian, B.R., Chandrasekhara, M.S.
Measurements in vertical plane turbulent planes
Trans. ASME, J., of Fluids Engineering, vol. 111, no. 1, pp. 69-77, March 1989.

Sestak, T.A., Howard, R.M., Heard, C.A.
Aerodynamic forces on flight crew helmets
Journal of Aircraft, vol. 26, no. 9, pp. 847-853, September 1989.

Shreeve, R.P., Elazar, Y.
Viscous flow in a controlled diffusion compressor cascade with increasing incidence
ASME Paper No. 88-GT-131, Presented at the 33rd International Gas Turbine and Aeroengine Congress and Exhibition, Toronto, June 5-8, 1989.

Ziola, S.M., Gorman, M.R.
Transverse matrix cracking and longitudinal splitting in [02, +30]s graphite/epoxy tensile coupons with edge notches as determined by acoustic emmission
Journal of Acoustic Emission, 8, no. 3, 1989.

DEPARTMENT OF ADMINISTRATIVE SCIENCES

CONFERENCE PRESENTATIONS

Abdel-Hamid, T.K.
An integrative system dynamics perspective of software project management: Examples of project estimation and scheduling experiments
The 1989 Society for Computer Simulation Western Multiconference, January 4-6, 1989.

Abdel-Hamid, T.K.
Modeling the software development process: Before, during, and after
The First Software Project Dynamics Modeling Workshop, Monterey, CA, October 3-4, 1989.

Abdel-Hamid, T.K.
On the utility of historical project statistics for cost and schedule estimation
The 23rd DoD Cost Analysis Symposium, September 4-8, 1989.

Abdel-Hamid, T.K.
The elusive silver lining: How we fail to learn from failure in software development
CISR Summer Session, MIT, June 12-15, 1989.

Bui, T.
Computerized decision rooms: Technical and managerial perspectives
INSEAD, Fontainebleau, France, November 1989.

Bui, T.
Cognitive limitations under crises
University of Fribourg, Switzerland, Commencement Speech, September 1989.

Bui, T.
Learning business software: Do training methods and trainee's background matter?
University of Fribourg, Switzerland, Inter-faculty Research Seminar, October 1989.

Couger, J.D., Borovits, I., Zviran, M.
Comparison of motivating environments for programmer/analysts and programmers in the U.S., Israel, and Singapore
HICSS 22 - Proceedings of the 22nd Hawaii International Conference System Sciences, pp. 316-323, Hawaii, January 1989.

Eitelberg, M.J.
The military as an agent of social change
Presented at the Biennial Conference of the Inter-University Seminar on Armed Forces and Society, Baltimore, MD, October 1989.

Eitelberg, M.J.
Military representation: Reflections and random observations
Presented at the 7th Annual Convention of the American Psychological Association, New Orleans, LA, August 1989.

Eitelberg, M.J.
Aptitude test scores of military personnel assigned to C3I jobs: Trends and prospects
Presented at the 43rd International Convention and Exposition of the Armed Forces Communications and Electronics Association, Washington, DC, June 1989.

Eitelberg, M.J.
Military representation: Reflections and random observations
Presented at the Biennial Conference on the Inter-Univeristy Seminar on Armed Forces and Society, Balitmore, MD, October 1989.

Giladi, R., Zviran, M.
A methodology for CAD/CAM policy formation
Proceedings of the 24th Annual Conference on Data Processing, IPA, Jerusalem, pp. 165-176, November 1989.

Liao, .S.S, Boger, D.C.
Competition in defense acquisition
Presented at the 33rd ASD/Industry Cost Workshop, Monterey, CA, April 19, 1989.

Liao, S.S., Boger, D.C.
Aircraft modifications cost study
Presented at the 33rd ASD/Industry Cost Workshop, Monterey, CA, April 19, 1989.

McCaffery, J.L.
Budget training
First Annual Conference on Public Budgeting and Financial Management, Section on Budgeting and Financial Management, Washington, DC, November 4, 1989.

McCaffery, J.L.
Computer skills and training
Presented at the Conference of the American Society for Public Administration, Miami, FL, April 11, 1989.

McCaffery, J.L.
Ethics and Federal Financial Managers
Annual Meeting of the San Fransicso Bay Area Financial Managers Council, August 14, 1989.

Mehay, S., Gonzalez, R.
Defense burden sharing among formal allies: An empirical test
Presented to the Annual Meetings of the Public Choice Society, Orlando, FL, March 1989.

Mehay, S., Solnick, L.
Defense spending and state economic growth
Presented to the Annual Meeting of the Western Regional Science Association, San Diego, February 1989.

Moore, T.P.
Overview of the use of measures of effectiveness in the Navy supply system
7th Annual Logistics Symposium, Naval Postgraduate School, Monterey, CA, May 13, 1989.

Moore, T.P.
An inventory control process for low attrition repairable items
CORS/TIMS/ORSA Joint Meeting, Vancouver, BC, Canada, May 10, 1989.

Roberts, B.J.
Postaudit of government capital investment projects
Presented at the 1989 Association of Government Accountants Professional Development Conference, Los Angeles, CA, June 26-28, 1989.

San Miguel, J.
Impact on organization strategy, managerial autonomy environmental uncertainty and size of budget characteristics
International Conference on Research in Management Control Systems, London Business School, July 1989.

San Miguel, J.
A framework for management systems in manufacturing and service organizations
Presented to the Joint TIMS/ORSA National Meeting, New York, October, 1989.

Suchan, J.
The written communication habits of public sector professionals: A case study
The Association for Business International Conference, Las Vegas Nevada, November 1989.

Thomas, G.
Preliminary estimates of qualified military available and interested
Proceedings of the 1989 Recruiting Research Coordination Conference, U.S. Army Recruiting Command, Fort Sheridan, IL.

Trietsch, D.
Decomposing the problem of transfer lot sizing for batch processing on consecutive machines
CORS/TIMS/ORSA Conference at Vancouver, May 8-10, 1989.

CONTRIBUTIONS TO BOOKS

Fann, G.
Management systems
Asserting and Reasserting the Role of Business Education, Reston, VA, pp. 181-188, NBEA Association, 1989.

Roberts, N.C., King, P.
The process of public policy innovation
Research on the Management of Innovation, vol. 2, A. Van De Ven., S. Poole, and H. Angle (Eds), New York: Ballinger, 1989.

Smeltzer, L., Fann, G.
Analysis of competitors as a source of information in small business management
Advances of Competitive Intelligence, pp. 189-200, Vienna, Virginia: Society of Competitor Intelligence Professionals, 1989.

PUBLISHED PAPERS

Abdel-Hamid, T.K.
A study of staff turnover, acquisition, and assimilation and their impact on software development cost and schedule
Journal of Management Information Systems, September 1989.

Abdel-Hamid, T.K.
The dynamics of software project staffing: A system dynamics based simulation approach
IEEE Transactions on Software Engineering, February, 1989.

Abdel-Hamid, T.K., Madnick, S.E.
Software productivity: Potential, actual, and perceived
System Dynamics Review, Summer, 1989.

Abdel-Hamid, T.K., Madnick, S.E.
Lessons learned from modeling the dynamics of software project management
Communications of the ACM, December 1989.

Ahituv, N., Neumann, S., Zviran, M.
Factors affecting the policy for distributed computing resources
MIS Quarterly, vol. 13, no. 4, pp. 389-401, December 1989.

Boger, D.C., Greer, W.R., Liao, S.S.
Competition in defense acquisition: Myths and facts
Defense Analysis, vol. 5, no. 3, pp. 245-255, Fall 1989.

Boger, D.C., Greer, W.R., Liao, S.S.
Competition in defense acquisition: Myths and facts
Defense Analysis, vol. 5, no. 3, pp. 245-255, 1989.

Boger, D.C., Greer, W.R., Liao, S.S.
Separating myths from facts in competitive weapons systems acquisition
Proceedings of the 1989 Acquisition Research Symposium, pp. 201-207, October 1989.

Boger, D.C., Greer, W.R., Liao, S.S.
Separating myths from facts in competitive weapons acquisition
Acquisition Research Symposium, Defense Systemes Management College, Fort Belvoir, VA, pp. 201-208, October 1989.

Bradley, R.T., Roberts, N.C.
Relational dynamics of charismatic organization: The complementarity of love and power
World Futures: The Journal of General Evolution, 27:87-123, 1989.

Bradley, R.T., Roberts, N.C.
Network structure from relational data: Measurement and inference in four operational models
Social Networks, 11(2):89-134, 1989.

Bui, T.
The negotiable alternative identifier (NAI): A solution concept for group decision and negotiation support system
SCIMA Journal of Management Science and Cybernetics, Summer 1989.

Bui, T.
La qualite de la gestion en situation de crise (Managerial decision quality under crisis situations)
Die Unternehmung, (Swiss Journal of Management Science), May 1989.

Bui, T.
Non-Cooperation in GDSS: Problems and solutions
SCIMA Journal of Management Science and Cybernetics, Fall 1989.

Dolk, D.R., Kridel, D.J.
Towards a symbiotic expert system for econometric modeling
Proceedings of the 22nd Hawaii International Conference on System Sciences, vol. III, IEEE Computer Society, pp. 3-13, January 1989.

Eitelberg, M.J.
Global trends to the year 2000: Implications for U.S. security
The Washington Quarterly, pp. 5-24, Spring 1989.

Eitelberg, M.J.
How to acquire and train skilled personnel to employ and maintain complex developing C3I systems
Signal, pp. 101-103, September 1989.

Evered, R.
Transforming managerial and organizational research: Creating a science that works
The Handbook for Managerial Research, 1989.

Evered, R., Selman, J.
Coaching and the art of management
Organizational Dynamics, pp. 16-32, Fall 1989.

Fann, G., Lynch, D.
A longitudinal study of attitudes toward the microcomputer as a writing tool
Office Systems Research Journal, 1989.

Fann, G., Lynch, D.
Assessing our audience: Business communication students' experiences with and attitudes toward the microcomputer
Journal of Technical Writing and Communication, 1989.

Fann, G., Lynch, D., Murranka, P.
Integrating technology: Attidtudes as a determinant of the use of the microcomputer in business communication
Journal of Educational Technology Systems, 17(4), pp. 307-317, 1989.

Fann, G., Smeltzer, L.
Communication attributes used by small business owner/managers for operational decision making
Journal of Business Communication, 26 (4), pp. 305-321, 1989.

Fann, G., Smeltzer, L.
The use of information from competitors and about competitors in small business management
Entrepreneurship: Theory and Practice, 13, (4), pp. 35-36, 1989.

Gates, W.
Department of defense procurement policy reform: An evolutionary perspective
Journal of Cost Analysis, Fall 1989.

Haga, W.J., Zviran, M.
Cognitive passwords: Key to easy access control
Computers and Security, March 1989.

Haga, W.J., Zviran, M.
Cognitive passwords - From theory to practice
Data Processing and Communications Security, vol. 13, no. 3, pp. 19-23, Summer 1989.

Haga, W.J., Zviran, M.
Cognitive passwords: From theory to practice
Data Processing and Communications Security, vol. 13, no. 3, pp. 19-23, Summer 1989.

Henderson, D.
The preverse effects of a variable oil import fee
The Energy Journal, vol. 10, no. 4, pp. 159-170, October 1989.

Henderson, D.
Safety and economy
Barron's, August 21, 1989.

Henderson, D.
Less good than harm
Barron's, July 31, 1989.

Henderson, D.
The ugly truth about trade
Fortune, June 5, 1989.

Henderson, D.
Who needs a citizens corps?
Barron's, April 24, 1989.

Henderson, D.
Are we all supply-siders now?
Contemporary Policy Issues, vol. VII, no. 4, pp. 116-128, October 1989.

Henderson, D.
The supply-side tax revenue effects of the child care tax credit
Journal of Policy Analysis and Management, vol. 8, no. 4, pp. 673,-675, Fall 1989.

Henderson, D.
VIF mortis est: A rejoinder to singer
The Energy Journal, vol. 10, no. 4, pp. 173-174, October 1989.

Henderson, D.
Henderson's law of heroic movies
Reason, July 1989.

Henderson, D., Kriegel, D.A.
Pay comparability: U.S. Navy pilots vs. airline pilots
Armed Forces and Society, vol. 15, no. 2, pp. 271-281, Winter 1989.

Johnson, L., Thomas, G.
Modeling commute behavior
Proceedings of the 1989 Joint Statistical Meetings, American Statistical Association, Alexandria, VA, August 1989.

Jones, L.R., McCaffery, J.L.
Restraint management in Canada in the 1980's
Greewood Press, pp. 210, 1989.

Kamel, M.N. Hsiao, D.K
Heterogeneous databases: Proliferations, issues, and solutions
IEEE Transactions on Knowledge and Data Engineering, vol. 1, no. 1, pp. 45-62, March 1989.

Lamm, D.V.
Why firms refuse DoD business: An analysis of rationale
Federal Publications Inc., Washington, DC, 1989.

Liao, S.S.
Modifications and extensions: Applying the learning curve formula
Program Manager, vol. XVIII, no. 3, pp. 40-46, May-June 1989.

McCaffery, J.L.
Strategies for achieving budgetary goals
Handbook of Public Administration, Jossey-Bass: San Francisco, London, pp. 290-301, 1989.

McCaffery, J.L.
Making the most of strategic planning and management
Managing Public Programs, Jossey Bass: San Francisco- London, pp. 193-210, 1989.

McCaffery, J.L.
Reflections on the deficit
Newsletter Section on Budgeting and Financial Management, American Society for Public Administration, pp. 3-4, Winter 1989.

Mehay, S., Gonzalez, R., Folsom, R.
Bureaucracy publicness and local government expenditures revisited
Public Choice, vol. 62, no. 1, pp. 71-78, July 1989.

Mehay, S., Looney, R.
Casual factors in U.S. postware defense spending: The empirical dimension
Defense Analysis, vol. 5, no. 2, June 1989.

Moses, O.D.
The impact of accounting procedures on learning rates
Proceedings of the 1989 Annual Meeting of Decision Sciences Institute, pp. 123-125, November 1989.

Moses, O.D.
Determinants of contractor pricing strategy
Program Manager, pp. 32-43, July-August 1989.

Roberts, N.C., King, P.
Public management executives: Charting a course admist the political swirl
Organizational Dynamics, pp. 63-79, Winter, 1989.

San Miguel, J.
H.H. Heinz Company and NCR Corporation
Financial Accounting and Corporate Reporting: A Casebook, 2nd Edition, BPI/IRWIN, 1989.

Schneidewind, N.F.
Distributed system software design paradigm with application to computer networks
IEEE Transactions on Software Engineering, vol. 15, no. 4, pp. 402-412, April 1989.

Schneidewind, N.F.
Scanning the issue - special section on software maintenance
Proceedings of the IEEE, vol. 77, no. 4, pp. 507-508, April 1989.

Schneidewind, N.F.
Software maintenance: The need for standardization
Proceedings of the IEEE, vol. 77, no. 4, pp. 618-624, April 1989.

Smeltzer, L., Fann, G.
Correlations among organizational climate, apprehension about communication, and locus of control in mid-level bank managers
Psychological Reports, 64, pp. 1143-1146, 1989.

Smeltzer, L., Fann, G.
External networking: Differences by gender
Journal of small business management, 27(2), pp. 25-32, 1989.

Smeltzer, L., Fann, G.
Comparison of managerial communication patterns in small entrepreneurial and large, mature organizations
Group and Organizational Studies, 14(2), pp. 198-215, 1989.

Solnick, L.M.
Marital status, children and female quitting
Proceedings of the 41st Annual Meeting, Industrial Relations Research Association, 1989.

Suchan, J., Colucci, R.
Communication efficiency between high-impact and bureaucratic written communication
Management Communication Quarterly, vol. 2, no. 4, pp. 452-484, Spring 1989.

Zviran, M., Blow, R.
A computer-based diabetes monitoring system
Journal of Medical Systems, vol. 13, no. 5, pp. 293-308, October 1989.

TECHNICAL REPORTS AND NOTES

Boger, D.C., Greer, W.R., Liao, S.S.
Competitive weapon systems acquisition: Myths and facts
Prepared for the Naval Postgraduate School, NPS-54-89-04, March 1989.

Boger, D.C., Liao, S.S.
Competitive weapon systems acquisition: Myths and facts
Prepared for the Naval Postgraduate School, NPS-54-89-04, March 1989.

Dolk, D.R., Euske, K.J.
End-user computing control strategies: An analysis of two organizations
Prepared for the Naval Postgraudate School, NPS-54-89-012, October 1989.

Gates, W.
Department of defense procurement policy reform: An evolutionary perspective
Prepared for the Naval Postgraduate School, NPS-54-89-01, January 1989.

Gorman, L., Thomas, G.
An analysis of enlistment motivations for the United States Army reserve recruits
Prepared for the Naval Postgraduate School, NPS-54-90-003, November 1989.

Henderson, D.
Child care tax credits: A supply-side success story
National Center for Policy Analysis, Policy Report no. 40, July 1989.

Mehay, S.
An enlistment supply and forecasting model for the U.S. Army reserve
Prepared for the U.S. Army Recruiting Command, Ft. Sheridan, ILL, USAREC SR-89-2, July 1989.

Moses, O.D.
Estimating and controlling the cost of extending technology: A revision and extension
Prepared for the Naval Postgraduate School, NPS-54-89-06, March 1989.

Moses, O.D.
Estimating and explaining the cost of high-technology systems: The case of military aircraft
Prepared for the Naval Postgraduate School, NPS-54-89-07, May 1989.

Roberts, B.J.
Managing planned change: A decade of experience in American military organizations
Prepared for the Naval Postgraduate School, NPS-54-89-05, 1989.

Schneidewind, N.F.
Software maintenance: The need for standardization
Prepared for the Naval Postgraduate School, NPS-54-89-02, February 1989.

Schneidewind, N.F.
How a standardized change management methodology can improve software maintenance
Prepared for the Naval Postgraduate School, NPS-54-89-09, May 1989.

Suchan, J.
Investigative report writing: A field study
Defense Personnel Security Research and Educational Center, PERS-SR-89-009, 34 pages, March 1989.

Thomas, G., Kocher, K., Roberts, B.
1987 U.S. Army membership, accession and loss profiles: Volume II, active duty
Prepared for the Naval Postgraduate School, NPS-54-89-10, June 1989.

Trietsch, D.
Polynomial transfer lot sizing techniques for batch processing on consecutive machines
Prepared for the Naval Postgrauduate School, NPS-54-89-011, 1989.

DEPARTMENT OF COMPUTER SCIENCE

CONFERENCE PRESENTATIONS

Berzins, V
A graphical interface for computer-aided prototyping systems
Hawaii International Conference on System Sciences, January 3-6, 1989.

Hsiao, D.K.
Heterogeneous databases: Proliferations, issues, and solutions
Heterogeneous Databases Workshop, Sponsored by the National Science Foundation and Northwestern University, Chicago, December 1989.

Hsiao, D.K.
Heterogeneous databases: Proliferations issues, and solutions
International Federation of Information Processing, Working Group 2.6 (Databases), Sweden, June 12-14, 1989.

Luqi
Computer-Aided prototyping of embedded software systems
Computer Science Department, University of Minnesota, Minneapolis, Minnesota, March 1989.

Luqi
Handling timing constraints in rapid prototyping
22nd Annual Hawaii International Conference on System Sciences, Kailua-Kona, Hawaii, January 1989.

Luqi
Rapid prototyping in real-time systems
22nd Annual Hawaii International Conference on System Sciences, Panelist in the Minitrack on Hard Real-Time Systems, Kailua-Kona, Hawaii, January 1989.

Luqi, Berzins, V.
Graphical tools for a computer aided prototyping system
22nd Annual Hawaii International Conference on System Sciences, Kailua-Kona, Hawaii, January 1989.

Rowe, N.C., Lewis, D.H.
Vehicle path-planning using optics analogs for optimizing visibility and energy cost
NASA Conference on Space Telerobotics, Pasadena, CA, February 1989.

Shimeall, T.J.
Derivation of software failure regions
Informal Presentation at the 3rd Symposium on Software Testing, Analysis and Verification, Key West, Florida, 1989.

Wu, C.T.
Implementing visual database interface by using an object oriented language
Proceedings of the IFIP TC-2 Working Conference on Visual Database Systems, Tokoyo, Japan, April 3-7, 1989.

Wu, T., Hsiao, D.K.
Implementing visual database interface by using an object oriented language
Conference on Visual Database Systems, Tokoyo, Japan, April 1989.

Zyda, M.J.
Inexpensive three-dimensional visual simulation as workstation exhaustion
Graphics Colloquim at the University of California, Santa Cruz, California, October 27, 1989.

Zyda, M.J.
What we need to know build inexpensive 3D visual simulators in the future
Workshops on Standards for the Interoperability of Defense Simulators, Institute for Simulation and Training, University of Central Florida, Orlando, Florida, August 23-24, 1989.

Zyda, M.J.
Visual simulation research at the Naval Postgraduate School, meaningful performance workstation performance measurements
Sun Microsystems, Mountain View, California, March 28, 1989.

Zyda, M.J.
Simulation research at the Naval Postgraduate School, meaningful graphics workstation performance measurements
The 3rd Naval Digital MC&G Interest Group Meeting, Sponsored by the Naval Ocean Research and Development Activity, Stennis Space Center, Bay St. Louis, Mississippi,
February 1-2, 1989.

Zyda, M.J.
Meaningful graphics workstation performance measurements
NECUSE Workshop on Computer Graphics, Wellesley College, Wellesley, Massachusetts, January 20-21, 1989.

PUBLISHED PAPERS

Berzins, V., Lee, Y., Luqi
Generating displays for specifications in spec
Proceedings of IEEE COMPSAC 89, pp. 596-602, September 1989.

Berzins, V., Lee, Y.
Specifications based on attribute grammar
IEEE 13th Annual International Computer Software Applications Conference, Orlando, Florida, September 1989.

DeHaemer, M.J., Zyda, M.J.
Simplification of objects rendered by polygonal approximations
Abstract, 6th Annual Symposium on Computational Geometry, October 31, 1989.

Demurjian, S.A., Hsiao, D.K.
The multi-model databases system
Proceedings of International Phoenix Conference on Computer and Communications, March 1989.

Holtkamp, B., Hsiao, D.K., Lum, V.Y.
Heterogeneous database systems: MUSE-levels of integration
Proceedings of Heterogeneous Databases Workshop, Chicago, December 1989.

Hoppenstand, G.S., Hsiao, D.K.
Secure access and control with high access precision: An efficient approach to multilevel security
Database Security, II - Status and Prospects, Editor: C.E. Landwehr, North Holland, 1989.

Hsiao, D.K., Kamel, M.N.
Heterogeneous databases: Proliferations, issues, and solutions
IEEE Transactions on Knowledge and Data Engineering, Volume 1, No. 1, 1989.

Lundy, G.M., Luqi
Specifications of token ring protocol using systems of communicating machines
Proceedings of IEEE Conference on Systems Design and Networks, pp. 9-16, May 1989.

Lundy, G.M., Luqi
Specification and analysis of a token ring protocol using systems of communicating machines
Proceedings of Systems Design and Networks Conference, Santa Clara, California, May 23-25, 1989.

Luqi
Software evolution through rapid prototyping
IEEE Computer, pp. 13-25, May 1989.

Luqi
Rapid prototyping languages and expert systems
IEEE Expert, pp. 2-5, Summer 1989.

Luqi
Handling timing constraints in rapid prototyping
Proceedings of the 22nd Annual Hawaii International Conference on System Sciences, Kailua-Kona, Hawaii, pp. 417-424, January 1989.

Luqi, Lee, Y.
Interactive process of rapid prototyping
Proc. of IEEE 13th Annual International Computer Software Applications Conference, Orlando, Florida, September 1989.

Luqi, Lee, Y.
Interactive control of prototyping process
Proceedings of IEEE, COMPSAC 89, Orlando, Florida, pp. 447-454, September 1989.

Meyer-Wegener, K., Lum, V.Y., Wu, C.T.
Image management in a multimedia database system
Proceedings of the IFIPS Working Conference on Visual Database Systems, Tokoyo, April 1989.

Wu, C.T., Hsiao, D.K.
Implementing visual database interface by using an object oriented language
Proceedings of IFIP TC-2 Working Conference on Visual Database Systems, Tokoyo, Japan, pp. 105-126, April 1989.

Zaky, A.M., Sadayappan, P.
Optimal static scheduling of sequential loops on multiprocessors
Proceedings of the 1989 International Conference on Parallel Processing, Chicago, August 1989.

Zyda, M.J., Breden, W.O., Zanoli, J.J.
Graphics workstation, 3D visual simulation and photogrammetrically generated terrain databases
Computer Vision, Graphic and Image Processing, November 1989.

Zyda, M.J., Fichten, M.A., Jennings, D.J.
Performance expectations and measurements for workstation based 3D visual simulation
IEEE Computer Graphics and Applications, October 31, 1989.

TECHNICAL REPORTS AND NOTES

Berzins, B., Luqi
A student guide to Spec
Prepared for the Naval Postgraduate School, NPS-52-89-029, 1989.

Berzins, V., Kopas, R.
Specification of a robust network
Prepared for the Naval Postgraduate School, NPS-52-89-034, 1989.

Berzins, V., Kopas, R.
User's manual for the SPECDEF editor
Prepared for the Naval Postgraduate School, NPS-52-89-041, 1989.

Berzins, V., Kopas, R.
The design and implementation of a specification language type
Prepared for the Naval Postgraduate School, NPS-52-89-042, 1989.

Berzins, V., Wyrick, L.
Evaluation of technology transfer: Conventional DBMs to object oriented DBMs
Prepared for the Naval Postgraduate School, NPS-52-89-027, 1989.

Douglas, B., Luqi
A design database for rapid prototyping
Prepared for the Naval Postgraduate School, NPS-52-89-022, 1989.

Hsiao, D.K., Kamel, M.
Heterogeneous databases: Proliferations, issues, and solutions
Prepared for the Naval Postgraduate School, NPS-52-89-013, 1989.

Kopas, R., Berzins, V.
The design and implementation of a specification language type checker
Prepared for the Naval Postgraduate School, NPS-52-89-045, 1989.

Lee, Y.
A knowledge bases approach to program debugging
Prepared for the Naval Postgraduate School, NPS-52-89-060, 1989.

Lum, V.Y., Meyer-Wegener, K.
A multimedia database management system supporting contents in media data
Prepared for the Naval Postgraduate School, NPS-52-89-020, March 1989.

Lundy, B., Luqi
Specifications of token ring protocol using systems of communicating machines
Prepared for the Naval Postgraduate School, NPS-52-89-024, 1989.

Lundy, G.M., Gouda, M.
An exercise in protocol composition: Data compression
Prepared for the Naval Postgraduate School, NPS-52-89-058, 1989.

Lundy, G.M., Miller, R.E.
Specification and analysis of a CSMA/CD protocol using systems of communicating machines
Prepared for the Naval Postgraduate School, NPS-52-89-059, 1989.

Luqi
Multi-Level software analysis and testing in evolutionary software development
Prepared for the Naval Postgraduate School, NPS-52-89-056, 1989.

Luqi
Models for evolutionary software development
Prepared for the Naval Postgraduate School, NPS-52-89-055, 1989.

Luqi
Rapid prototyping languages for expert systems
Prepared for the Naval Postgraduate School, NPS-52-89-032, 1989.

Luqi
Computer languages for rapid prototyping
Prepared for the Naval Postgraduate School, NPS-52-89-023, 1989.

Luqi, Barnes, P.
Graphical support for reducing information overload in rapid prototyping
Prepared for the Naval Postgraduate School, NPS-52-89-028, 1989.

Luqi, Berzins, V.
Issues in language support for rapid prototyping
Prepared for the Naval Postgraduate School, NPS-52-89-026, 1989.

Luqi, Berzins, V.
Rapid prototyping languages in computer aided software engineering
Prepared for the Naval Postgraduate School, NPS-52-89-021, 1989.

Luqi, Berzins, V., Kraemer, B.
A proposed design for a rapid prototyping language
Prepared for the Naval Postgraduate School, NPS-52-89-045, 1989.

Luqi, Davis, T.
A software prototype of the message processor in a Navy C3I station - modeling and specification of hard real-time systems in PSDL
Prepared for the Naval Postgraduate School, NPS-52-89-015, 1989.

Luqi, Kraemer, B., Berzins, V.
Software analysis and testing through prototyping
Prepared for the Naval Postgraduate School, NPS-52-89-044, 1989.

Luqi, Lee, Y.
Interactive control of prototyping process
Prepared for the Naval Postgraduate School, NPS-52-89-025, 1989.

Miller, R.E., Lundy, G.M.
Specification and analysis of a data transfer protocol using systems of communicating machines
Prepared for the Naval Postgraduate School, NPS-52-89-012, 1989.

Mostov, I., Luqi
A graph model for software maintenance
Prepared for the Naval Postgraduate School, NPS-52-89-062, 1989.

Shimeall, T., Leveson, N.
An empirical comparison of software fault tolerance and fault elimination
Prepared for the Naval Postgraduate School, NPS-52-89-047, 1989.

Shimeall, T.J.
REACHER -- A reachability condition derivation tool
Prepared for the Naval Postgraduate School, NPS-52-89-050, 1989.

Shimeall, T.J.
FALTER -- A fault annotation tool
Prepared for the Naval Postgraduate School, NPS-52-89-051, 1989.

Shing, M.T., Mayer, M.M., Hefner, K.A.S.
A note on the maximum size of a rectilinear maze
Prepared for the Naval Postgraduate School, NPS-52-89-057, September 1989.

Wu, C.T., Turner, H., Antonopoulos, D.
ARGOS: PMS module user manual
Prepared for the Naval Postgraduate School, NPS-52-90-015, December 1989.

Yee, S.H., Rowe, N.C.
Three algorithms for planar-patch terrain modeling
Prepared for the Naval Postgraduate School, NPS-52-89-018, 1989.

Yin, W., Luqi, Tanik, M.
Rapid prototyping for software evolution
Prepared for the Naval Postgraduate School, NPS-52-89-014, 1989.

Zyda, M.J., Fichten, M.A., Jennings, D.H.
Graphics workstations and 3D visual simulation: Some performance expectations and measurements
Prepared for the Naval Postgraduate School, NPS-52-046, July 1989.

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

CONFERENCE PRESENTATIONS

Beck, T.A., Ha, T.T.
Capacity of a land mobile satellite system
Aerospace Applications Conference, Denver, CO, February 12-17, 1989.

Borchardt, R.L., Boyana, M.A., Ha, T.T.
CSMA and CSMA/CD wi random signal powers
Presented at the Phoenix Conference on Computer and Communications, Scottsdale, AZ, March 22-24, 1989.

Borchardt, R.L., Ha, T.T.
Packet communications in a multipath fading mobile radio network
Presented at the Phoenix Conference on Computer and Communications, Scottsdale, AZ, March 22-24, 1989.

Burl, J.B.
Effects of reduced order modeling on the control of a space station
IEEE International Conference on Control and Applications, April 6, 1989.

Cristi, R.
Edge detection by 2D recursive least squares and Markov random fields
6th Multidimensional Signal Processing Workshop, Asilomar Conference Grounds, Pacific Grove, CA, September 1989.

Cristi, R., Healey, A.J.
Adaptive identification and control of an autonomous underwater vehicle
Proceedings of the 6th International Symposium on Unmanned, Untethered Submersible Technology, Ellicott City, MD, June 1989.

Cristi, R., Michael, S.
Hybrid adaptive control by parallel processing and switched capacitor networks
Proceedings of the IEEE International Conference on Control and Applications, Jersalem, Israel, April 1989.

Ellianidis, P., Breakall, J.K., Adler, R.W.
An investigation of near fileds for HF Shipboard antennas - surface patch and wire grid modeling using numerical electromagnetics code
URSI/IEEE-AP-S International Symposium on Antennas and Propagation Conference, June 1989.

Fargues, M.P., Beex, A.A.
Toeplitz - derived eigendecompositions
Proceedings of the 23rd Asilomar Conference on Signals, Systems, & Computers, Pacific Grove, CA, October 30 - November 1, 1989.

Ha, T.T.
The effect of fading in mobile aloha radio communications
Vehicular Technology Conference, San Francisco, CA, May 1-3, 1989.

Ha, T.T., Borchardt, R.L.
Analysis of unslotted random access channel in a capture environment
International Conference on Communication, Boston, MA, June 11-14, 1989.

Hippenstiel, R., Oliveria, P.
Contributions to time-varying spectrum estimation using the instantaneous power spectrum (IPS)
International Conference on Acoustic, Speech, and Signal Processing, Glasgow, Scotland, May 1989.

Kraus, A.D.
Thermal advantages of a new microcircuit configuration
National Electronic Packaging Conference, Anaheim, CA, March 14, 1989.

Lee, C-H.
Modeling of EPLD in VHDL
Presented at the VHDL User's Group Meeting, October 22-25, 1989.

Lee, C.-H.
Affine invariant detection of noisy object
Proceedings of the International Conference on Image Processing (ICIP'89), Singapore, September 5-8, 1989.

Lee, C.-H.
Illumination modeling in 3-D sonar images
Presented at the 6th Workshop on Multidimensional and Signal Processing, September 6-8, 1989.

McCartin, J.T., Ha, T.T.
Ring model for local radio communications
Global Telecommunications Conference, Dallas, TX, November 27-30, 1989.

Michael, S.
Radiation insensitive linear networks: A new approach, improved results
Proceedings of the 1989 IEEE 26th Annual Conference on Nuclear and Space Radiation Effects, Marco Island, FL, July 1989.

Michael, S.
Stray insensitive programmable switched capacitor filter
Proceedings of the 32nd Midwest Symposium on Circuits and Systems, Champaign, Illinois, August 1989.

Moose, P.H.
The quantized detection algorithm
ICASSP-89, Glasgow, Scotland, May 1989.

Morgan, M.A.
SEM and the early time
Presented at the Workshop on Singularity Expansion Method, University of Alabama, Huntsville, AL, August 28, 1989.

Morgan, M.A.
Transient scattering measurements
Presented at the Workshop on Singularity Expansion Method, University of Alabama, Huntsville, AL, August 1989.

Morgan, M.A., Hurley, R., Schwering, F.W.
Computation of monopole currents using cylindrical harmonic expansions
IEEE Antennas and Propagation Symposium, San Jose, CA, June 21, 1989.

Moskovity, L., Feuer, A.
Adaptive control of a simple arm
Proceedings of the ACASP Conference, Glasgow, G.B., April 1989.

CONTRIBUTIONS TO BOOKS

Morgan, M.A.
Finite element and finite difference methods in electromagnetic scattering
Elsevier Science Publishing Co, 380 pages, 1989.

Morgan, M.A., Schwering, F.W., Glisson, A.W.
Antennas I: Fundamentals and numerical methods
Handbook of Microwave and Optical Components, 63 pages, 1989.

PUBLISHED PAPERS

Adler, J.W., Breakall, J.K., Pinion, D.J., Resnick, A.F.
Low-profile and antenna study
National Association of Broadcasters, May 1989.

Adler, R.W., O'Hara, T.M.
NEC-3 on a PC, revisited: Three years later
5th Annual Review of Progress in Applied Computational Electromagnetics, Conference Proceedings, pp. 594, March 1989.

Atwater, H.A.
Simplified design equations for microstrip line parameters
The Microwave Journal, vol. 32, no. 11, pp. 109, November 1989.

Borchardt, R.L., Ha, T.T.
Pseudo-Bayesian stability of slotted aloha with power capture
Computer Communications, vol. 12, no. 4, pp. 187-192, August 1989.

Burl, J.B.
Estimating the basic functions of the Karhunen-Loeve transform
IEEE Trans. on Acoustics, Speech, and Signal Processing, vol. 37, no. 1, pp. 99-105, 1989.

Burl, J.T., Grogan, T.M., Preston, W.J.
Effects of reduced order modeling on the control of a space station
Proceedings of the 1989 IEEE International Conference on Control and Applications, pp. RA-1-4, 1989.

Butler, J.T, Bender, E.A.
On the size of PLS's required to realize binary and multiple-valued functions
IEEE Transactions on Computers, C-38, pp. 82-98, January 1989.

Butler, J.T., Kerkhoff, H.G.
A module compiler for high-radix CCD-PLA's
International Journal of Electronics, vol. 67, no. 5, pp. 797-805, November 1989.

Butler, J.T., Tirumalai, P.T.
Prime and nonprime implicants in the numerization of multiple-valued logic functions
Proceedings of the 19th International Symposium on Multiple Valued Logic, pp. 272-282, May 1989.

Cristi, R., Feuer, A.
Stability of an overparametrized model
System and Control Letters, August 1989.

Fargues, M.P., Beex, A.A.
Highly parallel recursive inerative/toeplitz eigenspace decomposition
IEEE Transactions on ASSP, vol. 37, no. 11, pp. 1765-1768, November 1989.

Feuer, A., Goodwin, G.C.
Integral action in robust adaptive control
IEEE Transactions on Automatic Control, vol. AC-24, no. 10, October 1989.

Ha, T.T.
Personal computer communications via VSAT networks
IEEE Journal on Selected Areas in Communications, vol. 7, pp. 235-245, February 1989.

Janaswamy, R.
An accurate moment method model for the tapered slot antenna
IEEE Trans. Antennas & Propagation, vol. AP-37, no. 12, December 1989.

Lee, C.-H.
Image surface approximation with irregular samples
IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. II, no. 2, February 1989.

Morgan, M.A.
Differential equation based numerical methods in electromagnetics
Journal of Electromagnetic Waves and Applications, vol. 3, no. 2, pp. 87-181, March 1989.

Morgan, M.A., Hurley, R., Schwering, F.W.
Computation of monopole currents using cylindrical harmonic expansions
IEEE Antennas and Propagation Symposium, San Jose, CA, 4 pages, June 1989.

Morgan, M.A., P.J. Moser, H. Uberall
Finite element computation of complex resonant frequencies for penetrable axisymmetric bodies
Journal of Electromagnetic Waves and Applications, vol. 3, no. 2, pp. 129-142, March 1989.

TECHNICAL REPORTS AND NOTES

Hippenstiel, R., Bukofzer, D.
Walsh functions and related rectangular basis functions
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-62-89-024, September 1989.

Moose, P.H.
Theory of multi-frequency modulation
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-62-89-019, May 1989.

Panagiotis,
An Investigation of near fields for HF shipboard antennas-surface patch and wire grid modeling using the numerical electromagnetics code
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-62-89-016, January 1989.

Partridge, W.J., Therrien, C.W.
Image enhancement software for underwater recovery operations - user's manual
Prepared for Naval Undersea Weapons Engineering Station, Keyport, WA, NPS-62-89-023, June 1989.

DEPARTMENT OF MATHEMATICS

CONFERENCE PRESENTATIONS

Canright, D.
Buoyant convection near a solidifying paraboloid
Annual Meeting of the Society for Industrial and Applied Mathematics, San Diego, California, July 18, 1989.

Danielson, D.A., Snider, J.R.
Satellite motion around an oblate earth: An perturbation solution for all orbital parameters
Stowe, Vermont, 1989.

Gragg, W.B.
Going around on circles
Northern Illinois University Conference on Linear Algebra and Applicaitons, Dekalb, ILL, April 29, 1989.

Gragg, W.B.
Hermitian antiquaternion Jacob: Matrices
SIAM Conference on Control in the 90's: Achievements, Opportunities, and Challenges, San Francisco, CA, May 17, 1989.

Gragg, W.B.
Structures problems in numerical linear algebra
SIAM 1989 National Meeting, San Diego, CA, July 17, 1989.

Gragg, W.B., Reichel, L.
On singular values of Hankel operators of finite rand
International Symposium on the Mathematical Theory of Networks and Systems (MTNS-89), Amsterdam, The Netherlands, June 19, 1989.

Gragg, W.B., Reichel, L.
A divide and conquer method for unitary Eigen problem with application to signal processing
SIAM National Meeting, San Diego, CA, July 17, 1989.

PUBLISHED PAPERS

Brown, D.A., Garrett, S.L., Danielson, D.A.
Fiber optic flextensional hydrophones
Proceedings of the SPIE Symposium, Boston, MA, September 5-8, 1989.

Canright, D., Davis, S.H.
Similarity solutions for phase-change problems
Metallurgical Transactions 20A, pp. 225-235, February 1989

Danielson, D.A., Garrett, S.L.
Fiber optic flextensional hydrophones
Journal of Light Wave Technology, vol. 7, no. 12, pp. 1995-2002, December 1989.

Fredricksen, H.
Covering the deBruijn graph
4th Joint Swedish-Soviet International Workshop on Information Theory, pp. 63-64, August, 1989.

Fredricksen, H.
Information theory for me
The Joint Swedish-Soviet International Workshop on Information Theory, p. 11, August, 1989.

Frenzen, C.L.
Error bounds via complete montonicity for a uniform asymptotic expansion of the legendre function pn-m (cost z)
Proceedings of the International Symposium and Computational Analysis, Winnipeg, Manitoba, 1989.

Frenzen, C.L.
Error bounds for a uniform asymptotic expansion of the legendre function Qn-m (cost s)
SIAM Journal of Mathematical Analysis, 1989.

Gragg, W.B., Ammar, G.S.
Numerical experience with superfast real Toeplitz solver
Linear Algebra Applications 121, pp. 185-206, 1989.

Gragg, W.B., Reichel, L.
On singular values of Hankel operators of finite rank
Linear Algebra Applications 121, pp. 53-70, 1989.

Scandrett, C.L.
A comparison of several iterative techniques in the solution of symmetric banded equations on a two-pipe Cyber 205
Appl. Math. Comput., vol. 34, pp. 95-112, November 1989.

Scandrett, C.L., Kriegsmann, G.A.
Assessment of a new radiation damping model for structural acoustic interactions
Journal of Acoustic Society of America, vol. 86, pp. 788-794, August 1989.

TECHNICAL REPORTS AND NOTES

Canright, D., Morris, S.
Rayleigh-Taylor instability of a viscous film overlying a passive fluid
Prepared for the Naval Postgraduate School, NPS-53-89-012, February 1989.

Ghandehari, M., Pfiefer, R.
Self circumference in the Minkowski plane
Prepared for the Naval Postgraduate School, NPS-53-89-009, February 1989.

Goldstein, A.
A note on Smale's global Newton method
Prepared for the Naval Postgraduate School, NPS-53-89-016, August 1989.

Goldstein, A.
How good are global newton methods? Part I
Prepared for the Naval Surface Weapons Center, NPS-53-89-010, February 1989.

Goldstein, A.
On calculating analytic centers
Prepared for the Naval Postgraduate School, NPS-53-89-015, August 1989.

Gragg, W.B., Ammar, G.S.
Numerical experience with a superfast real toeplitz solver
Prepared for the Naval Postgraduate School and sponsored by the National Science Foundation, NPS-53-89-008, February 1989.

Gragg, W.B., Neta, N.
Fortran subroutines for the evaluation of the confluent hypergeometric functions
Prepared for the Naval Postgraduate School, NPS-53-89-014, August, 1989.

Gragg, W.B., Reichel, L.
A divide and conquer method for unitary and orthogonal eigenproblems
Prepared for the Naval Postgraduate School and sponsored by the National Science Foundation, February 1989.

Schoenstadt, A.L.
Future-State decision making under the generalized value system architecture
Sponsored by the U.S. Army TRADOC Analysis Command, NPS-53-89-013, July 1989.

DEPARTMENT OF MECHANICAL ENGINEERING

CONFERENCE PRESENTATIONS

Coumes, T.M., Greco, F.J., Ligrani, P.M., Subramanian, C.S.
Effects of bulk flow unsteadiness on laminar/turbulent in a straight channel
Paper HA5, American Physical Society, Division of Fluid Dynamics, 42nd Annual Meeting, NASA-AMES, CA, November 19-21, 1989.

Dutta, I.
Aging kinetics of metal matrix composites
Presented at the Naval Research Laboratory, Washington, DC, May 4, 1989.

Dutta, I.
Residual stresses and their effect on composite strength
Presented at the Fall Meeting of TMS-AIME, Indianapolis, IN, October 4, 1989.

Hettema, C.D., Shin, Y.S., Kim, K.S.
Analysis of circular viscoelastic waveguide absorber
Presented at the ASME Vibration Conference, Montreal, Canada, September 17-20, 1989.

Kim, K.S., Shin, Y.S.
Application of a new hilbert transform method for nonlinear identification
Proceedings of the 7th International Modal Analysis Conference, Las Vegas, January 30 - February 2, 1989.

Ligrani, P.M., Baun, L.R., Longest, J.M., Subramanian, C.S.
Development and structure of dean vortices in a curved channel with 40: Aspect Ratio
Paper HA4, American Physical Society, Division of Fluid Dynamics, 42nd Annual Meeting, NASA-Ames, CA, November 19-21, 1989.

Ligrani, P.M., Williams, W.W.
Effects of an embedded vortex on injectant from a single film cooling hole in a turbulent boundary layer
Paper 89-GT-189, ASME 34th International Gas Turbine and Aeroengine Conference and Exposition, Toronto, Canada, June 4-8, 1989.

Mostafa, S.I.M., Sarpkaya, T., Munz, P.
Numerical simulation of unsteady flow about cambered plates
27th Aerospace Sciences Meeting of the American Institute of Aeronautics and Astronautics, Reno, NV, AIAA Paper no: AIAA-89-0290, January 10-14, 1989.

Sathe, S.B., Peck, R.E., Tong, T.W.
An experimental study of combustion and heat transfer in inert porous media
Presented at the Western States Section/The Combustion Meeting, October 1989.

Sathe, S.B., Tong, T.W.
Transient heat and fluid flow in porous annuli
Presented at the AIAA Aerospace Sciences Meeting, Reno, NV, 1989.

Sathe, S.B., Tong, T.W.
On the reduction of natural convective heat transfer in rectangular enclosures
Presented at the 4th Asian Fluid Mechanics Conference, Hong Kong, 1989.

Shin, Y.S., Inverson, J.C., Kim, K.S.
Experimental studies on damping characteristics of bolted joints for plates and shells
Presented at the ASME Pressure Vessel and Piping Technology Conference, Honolulu, Hi, July 23-27, 1989.

Shin, Y.S., Maurer, G.J.
Vibration response of constrained visoelastically damped plates: Analysis and experiments
Presented at the 7th International Modal Analysis Conference, Las Vegas, NV, January 30 - February 2, 1989.

Subramanian, C.S., Ligrani, P.M., Green, J.G.
Interaction between a longitudinal embedded vortex and a wall jet in a turbulent boundary layer
Paper FC5, American Physical Society, Division of Fluid Dynamics, 42nd Annual Meeting, NASA, Ames, CA, November 19-21, 1989.

Subramanian, C.S., Ligrani, P.M., Green, J.G.
Interactions between a turbulent embedded vortex and turbulent wall jet
Paper T-6, Open Forum, 7th Symposium on Turbulent Shear Flows, Stanford University, Stanford, CA, August 21-23, 1989.

PUBLISHED PAPERS

Dutta, I., Bourell, D.L.
A theoretical and experimental study of 6061 Al-SiC MMC to identify the operative mechanism for accelerated aging
Materials Science and Engineering, A112, pp. 67-77, 1989.

Hettema, C.D., Shin, Y.S., Kim, K.S.
Analysis of circular visoelastic waveguide absorber
ASME Publication De-vol. 18-2, Machinery Dynamics - Applications and Vibration Control Problems, pp. 23-173, September 17-20, 1989.

Ligrani, P.M., Ortiz, A., Joseph, S.L., Evans, D.L.
Effects of embedded vortices on film-cooled turbulent boundary layers
ASME Transactions-Journal of Turbomachinery, vol. 111, no. 1, pp. 71-77, January 1989

Ligrani, P.M., Singer, B.A., Baun, L.R.
Spatial resolution and downwash velocity corrections for multiple-hole pressure probes in complex flows
Experiments in Fluids, vol. 7, no. 6, pp. 424-426, 1989.

Ligrani, P.M., Singer, B.A., Baun, L.R.
Miniture five-hole pressure probe for measurement of three mean velocity components in low speed flow
Journal of Physics E-Scientific Instruments, vol. 22, no. 10, pp. 868-876, October 1989.

Ligrani, P.M., Westphal, R.V., Lemos, F.R.
Fabrication and testing of subminiture multi-sensor how-wire probes
Journal of Physics E-Scientific Instruments, vol. 22, no. 4, pp. 262-268, April 1989.

Sarpkaya, T.
Wave forces on cylindrical piles
The Sea, vol. 9: Ocean Engineering Sciences, John Wiley & Sons, N.Y., pp. 169-195, 1989.

Sarpkaya, T., Elnitsky, J., Leeker, R.E.
Wake of a vortex pair on the free surface
Proceedings of the 17th Symposium on Naval Hydrodynamics, National Academy Press, pp. 53-60, 1989.

Sarpkaya, T., Elnitsky, J., Leeker, R.E.
Wake of a vortex pair on the free surface
Proceedings of the 17th Symposium on Naval Hydrodynamics, National Academy Press, pp. 53-60, 1989.

Sathe, S.B., Tong, T.W.
On the reduction of natural convective heat transfer in rectangular enclosures
Int. Comm. in Heat & Mass Transfer, 16, pp. 795-802, 1989.

Shin, P.Y., Haftka, R.T., Plaut, R.H., Watson, L.T.
Design of laminated plates for maximum buckling load
Journal of Composite Materials, vol. 23, pp. 348-369, April 1989.

Shin, Y.S., Iverson, J.C., Kim, K.S.
Experimental studies on damping characteristics of bolted joints for plates and shells
ASME Publication PVP-Vol. 158, Advances in Bolted Joint Technology, 1989.

Westphal, R.V., Ligrani, P.M., Lemos, F.R.
Subminiature hot-wire probes
NASA Technical Briefs, vol. 13, no. 10, pp. 40-41, October 1989.

TECHNICAL REPORTS AND NOTES

Dutta, I., Tiedemann, C.F., McNelley, T.R.
Effect of thermo-mechanical processing on the properties of a cast 5083Al-SiC metal matrix composite
Prepared for the Naval Postgraduate School, NPS-69-90-001, November 1989.

Metz, S.D., Smith, D.L.
Survey of gas turbine control for application to marine gas turbine propulsion system control
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-69-89-002, 1989.

DEPARTMENT OF METEOROLOGY

CONFERENCE PRESENTATIONS

Abbey, R.F., Elsberry, R.L.
Progress and plans for the ONR tropical cyclone motion initiative
Presented at the 18th Conference on Hurricanes and Tropcial Meteorology, American Meteorological Society, Boston, MA, 1989.

Bacon, A.B., Elsberry, R.L., Dobos, P.H.
Application of the lag-averaged technique to tropical cyclone track prediction
Presented at the 18th Conference on Hurricanes and Tropical Meteorology, American Meteorological Society, Boston, MA, 1989.

Black, P.G., Shay, L.K., Elsberry, R.L., Hawkins, J.D.
Response of the Gulf of Mexico to Hurrican Gilbert
Presented at the 18th Conference on Hurricanes and Tropical Meteorology, American Meteorological Society, Boston, MA, 1989.

Chang, C.-P.
A numerical study of mei-ye front
International Conference on East Asia and West Pacific Meteorology and Climate, Hong Kong, July 1989.

Chang, P.-C., Peng, M.S., Boyle, J.S.
Interannual variations of tropical divergent and rotational motions at 200mb during Northern winter
Presented at the 18th Conference on Hurricanes and Tropical Meteorology, American Meteorological Society, San Diego, CA, May 1989.

Change, C.-P., Peng, M.S., Boyle, J.S.
Interannual variations of torpical divergent and rotational motions in the upper troposphere during northern winter
Proceedings of the 18th Conference on Hurrican and Tropical Meteorology, San Diego, CA, May 16-19, 1989.

Davidson, K.L.
Wind stress characterization in SST and current varying coastal regions
Coastal Physical Oceanography (CoPO) Working Group Meeting on Air-Sea Interaction, Scripps Institute of Oceanography, La Jolla, CA, June 28-20, 1989.

Davidson, K.L.
Results from MIZEX and CEAREX and the implications for arctic leads
NOARL-WEST, Monterey, CA, October 1989.

Davidson, K.L.
Meteorological scientific questions in the CEAREX 9-month experiment
DOD Arctic Science and Engineering Conference, Cold Regions Research and Engineering Laboratory (CRREL), Hannover, NH, June 21-23, 1989.

Davidson, K.L., Skupneiwicz, C., Skagseth, O.
Wind stress measurements from a ship and a buoy
IARSS 12th Canadian Symposium on Remote Sensing, NORCSEX Session, Vancouver, B.C., Canada, July 10-14, 1989.

Davidson, K.L., Skupniewicz, C., de Leeuw, G.
Shipboard wind and humidity turbulence results - HEXMAX
IAMAP Symposium on Global Energy and Water Fluxes, Special Session on Evaporation and Energy Fluxes from the Ocean, University of Reading, Reading, U.K., July 31 - August 12, 1989.

Davidson, K.L., de Leeuw, G., Gathman, S.G., Jensen, R.R.
Verification of the Navy oceanic vertical aerosol model during FIRE
FIRE Science Meeting, Monterey, CA, July 10-14, 1989.

De Leeuw, G., Davidson, K.L.
Aerosol modeling in the marine atmospheric boundary layer
8th World Clean Air Congress, The Hague, The Netherlands, September 11-15, 1989.

De Leeuw, G., Davidson, K.L., Gathman, S.G., Jensen, D.
The Naval oceanic vertical aerosol model: Progress Report
AGARD Electromagnetic Wave Propagation Panel Symposium on Atmospheric Propagation in the UV, Visible, IR and MM-Wave Region and Related Systems Aspects, Copenhagen, Denmark, October 9-13, 1989.

De Leeuw, G., Davidson, K.L., Gathman, S.G., Noonkester, R.V.
Physical models for aerosol in the marine mixed-layer
Proceedings of the 44th Symposium of the Electromagnetic Propagation Effects, AGARD CP 453, San Diego, CA, May 15-19, 1989.

De Leeuw, G., Davidson, K.L., Gathman, S.G., Noonkester, R.V.
Modeling of aerosols in the marine mixed-layer
SPIE Proceedings, Vol. 1115, SPIE Conference on Propagation Engineering, Orlando, FL, March 27-31, 1989.

Dobos, P.H., Hagaman, B.M., Elsberry, R.L.
A prototype expert system for setting tropical cyclone wind conditions at Cubi Point, Phillippines
Presented at the 18th Conference on Hurricanes and Tropical Meteorology, American Meteorological Society, Boston, MA, 1989.

Durkee, P.A.
Global estimates of aerosol characteristics
Presented at the IAMAP'89 Symposium on Remote Sensing of Atmospherical Constituents, Reading, UK, July 31 - August 12, 1989.

Durkee, P.A.
Observations of aerosol-cloud interactions in satellite detected visible and near infrared radiance
Presented at the Symposium on the Role of Clouds in Atmospheric Chemistry and Global Climate, American Meteorological Society, Anaheim, CA, January 30 - February 2, 1989.

Durkee, P.A.
Global and regional analysis of aerosols and clouds: Tests for aerosol-cloud-climate mechanisms
Presented at the 18th Annual Meeting of the American Association for Aerosol Research, Reno, NV, October 10-13, 1989.

Elsberry, R.L.
International experiments to study tropical cyclones in the Western North Pacific
Presented at the 2nd International Workshop on Tropical Cyclones, Manila, Phillippines, November 1989.

Elsberry, R.L., Dobos, P.H.
Time consistency of track predictions aids for Western North Pacific tropical cyclones
Presented at the 18th Conference on Hurricanes and Tropical Meteorology, American Meteorological Society, Boston, MA, 1989.

Elsberry, R.L., Dobos, P.H.
Recent tropical cyclone motion research at the Naval Postgraduate School
Presented at the Tropical Cyclone Conference, Honolulu, HI, February 1989.

Geernaert, G.L., Davidson, K.L., Hanson, S.
Wind stress vector measurements during SAXON
IGARSS 12th Canadian Symposium on Remote Sensing, SAXON Session, Vancouver, B.C., Canada, July 10-14, 1989.

Haney, R.L.
Modeling topographic effects in the coastal transition zone (CTZ)
Presented at the CTZ Workshop, Oregon State University, July 25-28, 1989.

Haney, R.L.
Modeling topographic effects in the coastal ocean
Presented at the CoPo Numerical Modeling Workshop, University of New Orleans, October 30, 1989.

Haney, R.L.
Eddy generation mechanisms in Eastern boundary current regions
Office of Naval Research Site Review, Arlington, VA, June 19-20, 1989.

Harr, P.A.
Comparisons between five years of analyzed maritime cyclone characteristics and those derived from successive versions of an operational forecast model
Presented at the 12th Conference on Weather Analysis and Forecasting, October 2-6, 1989.

Lim, H., Lim, T.K., Chang, C.-P.
Nonlinear Kelvin wave-CISK modes and 30-60 day oscillations
IAMAP General Assembly, Reading, U.K., August 1989.

Lim, H., Lim, T.K., Chang, C.-P.
Effects of vertical wind shear on Kelvin wave-CISK modes
Presented at the International Conference on East Asia and West Pacific Meteorology and Climate, Hong Kong, July 1989.

Neta, B., Williams, R.T.
A comparative study of finite elements and finite differences for weather prediction
Presented at the 5th International Symposium on Numerical Methods in Engineering, Lausanne, Switzerland, September 11-1, 1989.

Nuss, W.A.
Warm frontal intensity in the oceanic boundary layers and its impact on cyclogenesis
Presented at the 12th Conference on Weather Analysis and Forecasting, Monterey, CA, October 1989.

Onstott, R.G., Shuchman, R.A., Davidson, K.L., Johannessen, J.A.
Scatterometer measurements of the ocean and ocean fronts during NORCSEX
Proceedings of the IGARSS 12th Canadian Symposium on Remote Sensing Session, Vancouver, B.C., Canada, July 10-14, 1989.

Peng, M.S., Williams, R.T
Dynamics of vortex motion on a tropical beta-plane
Presented at the International Conference on East Asia and the Western Pacific, Hong Kong, July 6-8, 1989.

Peng, M.S., Williams, R.T.
Instability of the tropcial cyclone radial profile and its association with cyclone movement
Presented at the 7th Conference on Atmospheric and Oceanic Waves and Stability, San Francisco, April 10-14, 1989.

Peng, P.C., Williams, R.T.
Dynamics of vortex asymmetrics and their influence on vortex motion on a b-plane
Proceedings of the 18th Conference on Hurricane and Tropical Meteorology, San Diego, CA, May 16-19, 1989.

Shaw, W.J.
NCAR electra measurements in FASINEX
International Workshop on the Airborne Measurement of Wind, Turbulence, and Position, Oberpfaffenhofen, FRG, July 1989.

Shaw, W.J.
Remote sensing observations of the land/sea breeze circulation in central California
Presented at the IAMAP 89 Assembly, Reading, U.K., August 1989.

Trizna, D.B., Davidson, K.L.
Correlation of marine radar cross section statistics with wind stress during NORCSEX
IGARSS 12th Canadian Symposium on Remote Sensing, NORCSEX Session, Vancouver, B.C., Canada, July 10-14, 1989.

Wash, C.H., Huffman, G., Gall, R.
Results of the synoptic meteorology instruction workshop
Presented at the 5th International Conference on Interactive Information and Processing Systems for Meteorology, January 29 - February 3, 1989.

Williams, R.T
Lectures in advanced numerical methods in numerical weather prediction
Presented at the Monterey Atmospheric Sciences Laboratory, International, April 1989.

Williams, R.T., Carr, L.E.
Barotropic vortex stability to perturbation from axisymmetry
18th Conference on Hurricane and Tropical Meteorology, San Diego, CA, May 16-19, 1989.

Williams, R.T., Peng, M.S.
The influence of topography on fronts
Presented at the IAMAP 5th Scientific Assembly, University of Reading, United Kingdom, July 31 - August 12, 1989.

Williams, R.T., Staniforth, A.N., Neta, B.
Solutions of a generalized strum-lioville problem
Computation of Ordinary Differential Equations, London, England, July 3-7, 1989.

PUBLISHED PAPERS

Allen, R.C., Durkee, P.A., Wash, C.H.
Snow/Cloud discrimination with multispectral satellite measurements
Journal of Appl. Meteorology, 1989.

Batteen, M.L., Haney, R.L., Tielking, T.A., Renaud, P.G.
A numerical study of wind forcing of eddies and jets in the California current system
J. Mar. Res., 47, pp. 493-23, March 1989.

Carr, L.E., Williams, R.T.
Barotropic vortex stability to perturbations from axisymmetry
Journal of the Atmospheric Sciences, 46, pp. 3177-3191, October 15, 1989.

Chang, C.-P.
Interannual variations of tropical divergent and rotational motions in the upper troposphere during Northern winter
Proceedings of the 18th Conference on Hurricanes and Tropical Meteorology, May 3-4, 1989.

Chen, J.-M.
Macroscopic behavior of moist-convective processes and an empirical cumulus parameterization
Presented at the 18th Conference on Hurricanes and Tropical Meteorology, (AMS), pp. 180-181, San Diego, CA, May 16-19, 1989.

De Leeuw, G., Davidson, K.L.
Mixed layer profiling with lidar and modeling of the aersol vertical structure
Journal of Atmospheric Oceanic Tech., April 1989.

De Leeuw, G., Davidson, K.L.
Aerosol modeling in the marine atmospheric boundary layer
Proceedings of the 8th World Clean Air Congress, The Hague, The Netherlands, Vol. 3, Elsevier Science, pp. 617-622, Amsterdam, The Netherlands, 1989.

De Leeuw, G., Davidson, K.L., Gathman, S.G., Nookester, R.V.
Modeling of aerosols in the marine mixed-layer
SPIE Proceedings of the Conference on "Propagation Engineering," Volume 115, pp. 1115-1127, Orlando, FL, March 27-31, 1989.

De Leeuw, G., Davidson, K.L., Gathman, S.G., Noonkester, R.V.
Physical models for aerosol in the marine mixed-layer
Proceedings of the 44th Symposium of the Electromagnetic Propagation Effects, AGARD CP 453, San Diego, CA, 40-1 to 40-8, May 15-19, 1989.

De Leeuw, G., Davidson, K.L., Gathman, S.L., Jensen, D.
The Naval oceanic vertical aerosol model: Progress report
Proceedings of the AGARD Electromagnetic Wave Propagation Panel Symposium on Atmosphersic Propagation in the UV, Visible, IR and MM-Wave Region and Related System Aspects, Copenhagen, Denmark, 17-1 to 17-11, October 1989.

Fiorino, M., Elsberry, R.L.
Contributions to tropical cyclone motion by small medium and large scales in the initial vortex
Mon. Wea. Rev., 117, pp. 721-727, 1989.

Fiorino, M., Elsberry, R.L.
Some aspects of vortex structure related to tropical cyclone motion
Journal of Atmos. Sci., 46, pp. 975-990, 1989.

Gerber, H., Chang, S., Holt, T.
Evolution of a marine boundary layer jet
Journal of Atmospheric Science, 46, pp. 1312-1326, 1989.

Haggerty, J.A., Durkee, P.A., Wattle, B.J.
A comparison of surface and satellite-derived aerosol measurements in the Western Mediterranean
Journal of Geophys. Res., 1989.

Intrieri, J.M., Little, C.G., Shaw, W.J., Banta, R.M., Durkee, P.A., Hardesty, R.M.
The land/sea breeze experiment (LASBEX)
Bull. Amer. Meteor. Soc., 1989.

Li, F., Large, W., Shaw, W., Walsh, E., Davidson, K.L.
Ocean radar backscatter relationship with near-surface winds: A case study during FASINEX
J. Phys. Oceanog., 19, pp.342-353, 1989.

Li, F., Large, W., Shaw, W.J., Walsh, E., Davidson, K.L.
Ocean radar backscatter relationship with near surface winds: A case study during the FASINEX
Journal of Physical Oceanography, 19, pp. 342-353, 1989.

Neta, B., Williams, R.T.
Rossby wave frequencies and group velocities for finite element and finite difference approximations to the vorticity divergence equations
Mon. Wea. Rev., 117, pp. 1439-1457, July 1989.

Nuss, W.A.
Air-sea interaction influences on the structure and intensification of an idealized marine cyclone
Mon. Wea. Rev., 117, pp. 351-369, 1989.

Onstott, R.G., Shuchman, R.A., Davidson, K.L., Johannessen, J.A., Skagseth, O.
Scaterometer measurements of the ocean and ocean fronts during NORCSEX
Proceedings of the IGARSS'89/12th Canadian Symposium on Remote Sensing, NORCSEX Session, pp. 1084-1088, Vancouver, D.C., Canada, July 10-14, 1989.

Peng, M.S., Loesch, A.Z.
Spectral evolution of baroclinic waves in continuously stratified Eady model with Ekamn dissipation
European Journal of Mechanics, B/Fluid, 8, pp. 441-455, 1989.

Shay, L.K., Elsberry, R.L., Black, P.G.
Vertical structure of the ocean current response to a hurricane
Journal of Phys. Oceanogr., 19, pp. 649-669, 1989.

Wash, C.H.
Meteorological applications of space shuttle photography
Geocarto International, 4, 1. pp. 38-48, March 1989.

TECHNICAL REPORTS AND NOTES

Elsberry, R.L.
ONR Tropical cyclone motion research initiative: Field experiment planning workshop
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-63-89-002, 1989.

Elsberry, T.R.
ONR tropical cyclone motion research initiative: Data assimilation considerations for field experiment analysis
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-63-89-006, 1989.

Elsberry, T.R.
Reflections on the impact of the fix type and accuracy on tropical cyclone track forecasts
Prepared for the Naval Environmenal Prediction Research Facility, NPS-63-89-004, July 1989.

Guest, P.S., Davidson, K.L.
CEAREX/"O" and "A" camp meteorology atlas
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-63-89-007, 1989.

Lackman, G.M., Guest, P.S., Davidson, K.L., Lind, R.J., Gonzalez, J.
CEAREX/POLARJOERN Meteorology atlas
Prepared for the Naval Postgraduate School, NPS-89-63-89-005, 1989.

Lind, R.J., Shaw, W.J.
Sea surface temperature fields derived from aircraft and ship observations during FASINEX
Prepared for the Naval Postgraduate School, NPS-63-89-001, 1989.

Rennick, M.A., Williams, R.T.
Final technical report of grant ATM8610354 air flow over large scale topography
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-63-89-003, June 1989.

Shaw, W.J., Davidson, K.L., Willis, Z., Groters, D.
Horizontal variability of mean refractive structure in the Arctic
Proceedings Conference on Microwave Propagation in the Marine Boundary Layer, NEPRF, Monterey, CA. NEPRF TR 89-02, pp. 2-140 to 2-161, January 1989.

Williams, F.R., Jung, G.H., Renard, R.J.
Forecasters handbook for Central America and adjacent waters
NEPRF Technical Report, 89-08, September 1989.

DEPARTMENT OF NATIONAL SECURITY AFFAIRS

CONFERENCE PRESENTATIONS

Abenheim, D.
Past, present, and future of West German security
General Consulate of the Federal Republic of Germany, San Francisco, CA, March 22, 1989.

Abenheim, D
The new German Army and the search for tradition
Hoover Institution Tower Talks, Stanford University, April 1989.

Abenheim, D.
The future role of the West German military in the Atlantic alliance
Heritage Foundation, Washington, DC, March 6, 1989.

Abenheim, D.
Reforging the iron cross: The search for tradition in the West German Armed Forces
American Institute for Contemporary German Studies, Washington, DC, March 6, 1989.

Abenheim, D.
German security issues
Clausewitz Society, Stanford University, May 7, 1989

Abenheim, D.
Defensive defense: Some historical comments on a new old idea
National Security Affairs Seminar, Hoover Institution, May 5, 1989.

Abenheim, D.
American perspectives on Germany in NATO
German-American Traveling Workshop, Hannover, FRG, June 14, 1989.

Abenheim, D.
US Army, NATO, and the future of Europe
Defense Language Institute, Monterey, CA, September 26, 1989.

Abenheim, D.
German-German relations and security policy
Consortium for Atlantic Studies, Arizona State University, Phoenix, AZ, September 30, 1989.

Abenheim, D.
German security issues
Naval Affairs Politico-Military Affairs 2011 Seminar, San Francisco, CA, May 15, 1989.

Abenheim, D.
Manning the German military
Department of History, Yale University, New Haven, Connecticut, November 6, 1989.

Abenheim, D.
Bundeswehr und tradition: Die suche nach dem gultigen erbe des deutschen soldaten
Ministry of Defense, Bonn, FRG, November 15, 1989.

Abenheim, D.
Military tradition in the Bundeswehr
German Studies Association, Milwaukee, Wisconsin, October 6, 1989.

Bradley, R.T., Roberts, N.C.
Holonomic processes in organizations
Presented to ORSA/TIMS Conference, New York, October 1989.

Breemer, J.S.
The Euro-Atlantic dimension of underwater security
Presented at the Conference on the Undersea Dimension of Maritime Strategy, Dalhousie University, Halifax, N.S., Canada, June 2, 1989.

Breemer, J.S.
The continuing need for forward deployment
Presented at the Conference on U.S. National Security for the 1990s, Southwest Missouri State University, Springfield, MO, April 28, 1989.

Laurance, E.J.
Minimizing the negative consequences of third world conflict: The prospects for controlling and counteracting the acquisition of destabilizing military capabilities
Presented at the CIA Sponsored Conference on Implications of a Changing Third World Military Environment, Science Applications International Corporation, McLean, VA, July 25-26, 1989.

Laurance, E.J.
Responding to the proliferation of Ballistic missiles in the third world: An analysis of potential regimes
Presented to the Annual Meeting of the International Security Studies Section of the International Studies Association, Whittier College, November 1989.

Laurance, E.J.
Missile proliferation and arms transfer research
Presented at the Conference on the Proliferation of Missiles: Problems, Prospects for Control and Research Agendas, Lawrence Livermore National Laboratory, May 1, 1989.

Looney, R.
A post-keynesian assessment of Saudi Arabian industrialization: The policy implications of declining government expenditures
Western Economic Association Conference, Lake Tahoe, June 22, 1989.

Looney, R.
Major issues in Persian gulf industrialization efforts
Central Intelligence Agency Conference on Current Developments in the Persian Gulf, Washington, March 21, 1989.

Looney, R.
Effects of economic environment on Arab industrialization
Middle East Economic Association Meetings, Atlanta, December 30, 1989.

Magnus, R.H.
Political possibilities in past-withdraw Afghanistan
Presented at the 2nd CENTAF Symposium on Southwest Asia, Shaw, AFB, South Carolina, March 1989.

Magnus, R.H.
Current views of the Mujahidin
Presented at the 6th Annual Meeting of the American Council for the Study of Islamic Societies, Villanova University, Villanova, PA, May 1989.

Olsen, E.A.
New security patterns in Northeast Asia
Council on US-Korea Security Studies, Seoul, November 1-19, 1989.

Olsen, E.A.
Future on the ROK Navy
ROK Navy, Yonsei Universiy in Seoul, July 7-14, 1989.

Olsen, E.A.
Western Pacific security
Conference on Undersea Power, Dalhousi University, Halifax, NS Canada, June 22-24, 1989.

Olsen, E.A.
Future of Western Pacific security
ISA Annual Meeting Chaired Panel, London, March 29-31, 1989.

Roberts, N.C.
Ego development and cognitive maps: The holonomic implications
Presented to the 4th Holonomy Social Systems Conference, Esalen CA, 1989.

Roberts, N.C.
Strategy-Making process
Joint Staff (J-5) Strategy Division, Washington, DC, August 1989.

Roberts, N.C., King, P.
Stakeholder discussion group: A forum for the crafting of public policy
Presented to the North American Conference on Peacemaking and Conflict Resolution, Montreal, February 27 - March 5, 1989.

Roberts, N.C., King, P.J.
Public entrepreneurship: A typology
Academy of Management, Washington, DC, August 1989.

Tollefson, S.D.
Brazilian missiles: Implications for regional and global security
XV International Congress of the Latin American Studies Association, December 5, 1989.

Tritten, J.J.
Naval arms control: An idea whose time has yet to come
Presented at the Atlantic Council NATO Youth Exchange Program, Naval Station Treasure Island, San Francisco, CA, September 1989.

Tritten, J.J.
Naval arms control
Presented at the National Security Studies Program at California State University, San Bernardino, CA, April 1989.

Tritten, J.J.
Naval arms control
Presented at the National Defense University Strategic Concepts Development Center, Washington, DC, April 1989.

Tritten, J.J.
The RAND strategy assessment system at the Naval Postgraduate School
Presented at the Joint National Meeting of the Operations Research Society of America (ORSA) and the Institute of Management Sciences (TIMS), Vancouver, British Columbia, May 1989.

Tritten, J.J.
Scenarios simulations and games
Presented at the Defense Language Institute, Monterey, CA, March 1989.

Tritten, J.J.
Are nuclear and non-nuclear war related?
Presented at the 4th Conference on Crisis Stability and the Offense/Defense Relationship: New Leadership - New Directions, Monterey, CA, August 1989.

CONTRIBUTIONS TO BOOKS

Bruenau, T.C.
Paraguay
Lating American Caribben Contemporary Record, vol. VII, 1987-1988, New York: Holems and Meier, 1989.

Olsen, E.A.
US-Japan security relations: The case for a strategic fairness doctrine
Collective Defense or Strategic Independence?: Alternative Strategies for the Future, Lexington, MA: Lexington Books and The Cato Institute, 1989.

Olsen, E.A.
Japan's security policy options
Security, Strategy, and Policy Responses in the Pacific Rim, Boulder: Lynee Rienner Publisher, 1989.

Olsen, E.A.
Ilbon hau ui anbo
Korean and Maritime Strategy Security, Seoul: Yonsei University, Institute of East and West Studies, 1989.

Olsen, E.A.
Political stability and/or liberalization in South Korea
Modernizing East Asia: Economic and Cultural Dimension of Political Change, New York: Institute of Asian Studies, St. John's University, 1989.

PUBLISHED PAPERS

Bradley, R.T., Roberts, N.C.
Relational dynamics of charismatic organization: The complementarity of love and power
World Futures: The Journal of General Evolution, 27:87-123, 1989.

Bradley, R.T., Roberts, N.C.
Network structure from relational data: Measurement and inference in four operational models
Social Networks, vol. 11, no. 2, pp. 89-134, 1989.

Breemer, J.S.
Soviet submarines: Design, development, and tactics
London, Jane's, February 1989.

Breemer, J.S.
The Soviet Navy's SSBN Bastions: Why explanations matter
Journal of the Royal United Servies Institute for Defence Studies, Winter 1989.

Breemer, J.S.
Defeating the submarine: Choosing ASW strategies - Part 3: The post-war era
Naval Forces, Fall 1989.

Breemer, J.S.
Third world ASW requirements
Naval Forces, January 1989.

Bruenau, T.C., Hewitt, W.E.
Paterns of church influence in Brazil's political transition
Comparative Politics, pp. 39-61, October 1989.

Bruneau, T.C.
Portugal fifteen years after the April revolution
Universities Field Staff International Reports, August 1989.

Garrett, S.L.
High sensitivity fiber-optic flexural disk hydrophone with reduced acceleration response
Fiber and Integrated Optics 7 (3), 1989.

Garrett, S.L., Hofler, T.J., Atchley, A.A.
Simple demonstration of a thermoacoustic sound souce
J. Acoust. Soc. Am. 85, S112, 1989.

Garrett, S.L., Hofler, T.J., Fitzpatrick, M., Susall, M.P., Volker, R., Harris, D., Brynes, R.B., Cameron, C.B., Murray, F.M.
Thermoacoustic refrigerator for space applications
J. Acoust. Soc. Am. 85, S48, 1989.

Garrett, S.L., Larraza, A., Putterman, S.
Dispersion relations for gravity waves in a deep fluid: Second sound in a stormy sea
Bull. Am. Phys. Soc. 34(10), 2276, 1989.

Lonney, R.
Oil revenues and viable development: Impact of the Dutch disease on Saudi Arabian diversifications efforts
American Arab Affair, 1989.

Looney, R.
Gulf state manpower strategies for the 1990s
Middle East Executive Reports, 1989.

Looney, R.
An economic assessment of Oman's industrial diversifications efforts
Orient, 1989.

Looney, R.
Impact of the gulf war on human captial development in Iraq
Middle East Strategic Studies Quarterly, 1989.

Looney, R.
Mobilizing human resources in the gulf states: Key issues for the 1990's
Futurics, 1989.

Looney, R.
The impact of oil revenuse and external public borrowing on third world defense expenditures: The case of Venezuela
Scandinavian Journal of Development Alternatives, 1989.

Looney, R.
Patterns of remittances and labor migration in the Arab world
International Migration, 1989.

Looney, R.
Macroeconomic impacts of worker remittances on Arab world labor exporting countries
International Migration, 1989.

Looney, R.
The future of industrialization in the Arabian gulf region
OPEC Review, 1989.

Looney, R.
The relative impact of government expenditures on Arabian gulf industrial development, 1974-1985
Public Bugeting and Financial Management, 1989.

Looney, R.
Sructural adjustment in the Caribbean: The Jamaican approach toward stabilization
Scandinavian Journal of Development Alternatives, 1989.

Looney, R.
Casual factors in the United States defense spending: The empirical dimension
Defense Analysis, 1989.

Looney, R.
Military Keynesnanism in the third world: An assessment of non-military motives for arms production
Journal of Political and Military Sociology, 1989.

Looney, R.
The viability of Saudi Arabian industrial diversification efforts: The consequences of declining government expenditures
Revisita Internazionale di Scienze Economiche e Commerciali, 1989.

Looney, R.
An economic assessment of Bahrain's attempts at industrial diversification
Industrial Bank of Kuwait Papers, 1989.

Looney, R.
The role of military expenditures in the African economic crisis
The Jerusalem Journal of International Relations, 1989.

Looney, R.
Structural change in the Arabian gulf: Impact of the foreign work force
Population Bulleting of ESCWA, 1989.

Looney, R.
Factors affecting United States Naval expenditures
Naval Forces, 1989.

Olsen, E.A.
A Gorby' in Pyongyang
Christian Science Monitor, November 6, 1989.

Olsen, E.A.
Standing up for U.S. interests in Asia
Christian Science Monitor, March 29, 1989.

Olsen, E.A.
U.S. - ROK relations: Common issues and uncommon preceptions
Korea and World Affairs, Spring 1989.

Olsen, E.A.
Selective isolationism and the Japanese challenge
Asia-Pacific Review, Spring 1989.

Olsen, E.A.
How will Adam Smith play in China
Christian Science Monitor, January 24, 1989.

Olsen, E.A.
More liberal than thou
Far Eastern Economic Review, January 19, 1989.

Olsen, E.A.
Security implications of economic and political nationalism in the U.S. and South Korea
Journal of Northeast Asian Studies, Winter 1988-1989.

Olsen, E.A.
Hokoto ajia ni okeru nichi-bei no boei buntan (U.S. - Japan defense burdensharing in Northeast Asia)
Gendai no anzen hosho, (Today's National Security) February 1989.

Roberts, N.C., King, P.
Public management executives: Charting a course admist the political swirl
Organizational Dynamics, pp. 63-79, Winter 1989.

Roberts, N.C., King, P.J.
The process of public policy innovation
Research on the Management of Innovation, New York, NY, Harper and Row, pp. 303-335, 1989.

Roberts, N.C., King, P.J.
The stakeholder audit goes public
Organizational Dynamics, pp. 63-79, Winter 1989.

Stolfi, H.S.
Soviet Naval operational art
Fort Leavenworth, KS, Soviet Army Studies Office, pp. 147, October 1989.

Stolfi, H.S.
The German 7th Panzer division in France and Russia 1940-1941: German command style on the strategic offensive
Fleet Marine Force Reference Pamphlet, Washington, DC, U.S. Government Printing Office, pp. 161, November 1989.

Tollefson, S.D., Roett, R.
Brazil - The year of the elections
Current History, December 1989.

Tritten, J.J.
Strategic antisubmarine warfare
The Submarine Review, pp. 40-48, January 1989.

Tsypkin, M.
Turmoil in Soviet science
Report on the USSR, vol. 1, no. 29, pp. 14-17, July 21, 1989.

Tsypkin, M.
Gorbachev and the post-Chebrikov KGB: A commentary
Report on the USSR, vol. 1, no. 51, December 22, 1989.

Tsypkin, M.
Workers militia: Order instead of law
Report on the USSR, vol. 1, no. 46, pp. 14-17, November 17, 1989.

Tsypkin, M.
From state security to national security
Report on the USSR, vol. 1, no. 43, pp. 12-15, October 27, 1989.

Tsypkin, M.
The new thinking and quality of Soviet military manpower
Hoover Institution, Stanford University, pp. 19, 1989.

Yost, D.S.
Controlling SLCMs (sea-launched cruise missiles): The most difficult question
U.S. Naval Institute, Proceedings, vol. 115, pp. 60-70, September 1989.

Yost, D.S.
La France et la securite europeenne: un point de vue americain
Defense Nationale, vol. 45, pp. 39-56, October 1989.

TECHNICAL REPORTS AND NOTES

Bradford, D.L.
On-Site inspection as an enhancement to verification
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-56- 89-014, pp. 53, August 1989.

Fennell, P.T.
U.S. Navy strategy: Offensive strike or escort?
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-56-89-006, pp. 19, February 1989.

Garrett, S.A.
NATO deterrence and defense after the INF treaty
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-56-89-010, pp. 110, June 1989.

Hays, P.L.
SDI and strategy
Prepared for th · Defense Nuclear Agency, Alexandria, VA, NPS-56-89-021, Decemeber 1989.

Kartchner, K.M.
Issues and options for post-START secure reserve forces
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-56-89-001, pp. 35, July 1989.

Kartchner, K.M.
Summary of national policy guidance for secure reserve forces
Prepared for the Naval Posgraduate School, Monterey, CA, NPS-56-89-013, pp. 16, August 1989.

Kenny, J.M.
The dibb report: Three years after
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-56-89-016, pp. 70, August 1989.

Laurance, E.J.
Worldwide armament sales: Supply, demand, and forecast for the 1990s
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-56-89-020, December 1989.

Olsen, E.A.
Prospects for an increased Naval role of the republic of Korea in Northeast Asian security
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-56-89-009, March 1989.

Olsen, E.A.
The maritime strategy in the Pacific
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-56-89-004, 1989.

Olsen, E.A.
Prospects for an increased Naval role for the republic of Korea in Northeast Asian security
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-56-89-007, March 1989.

Roberts, N.C., King, P.J.
Public entrepreneurship: A typology
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-56-89-018, 1989.

Swartz, P.M., Breemer, J.S.
The maritime strategy debates: A guide to the renaissance of U.S. Naval strategic thinking in the 1980's
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-56-89-019, September 1989.

Tollefson, S.D.
Brazil, the United States and the missile technology control regime
Prepared for Naval Postgraduate School, December 1989.

Tritten, J.J.
Back to basics: Mahan for the 1990s
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-56-89-003, pp. 23, February 1989.

Tritten, J.J.
Naval arms control: An idea whose time has yet to come
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-56-89-015, pp. 23, August 1989.

Tritten, J.J.
Report on maritime/joint strategic planning journals
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-56-89-017, September 1989.

Tritten, J.J., Channell, R.N.
The RAND strategy assessment system at the Naval Postgraduate
Prepared for the Naval Postgraduate School, NPS-56-89-011, June 1989.

Tritten, J.J., Roberts, N.C.
Strategic management or strategic planning for defense?
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-56-89-002, pp. 34, February 1989.

Wegmann, D.G.
Net technical assessment
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-56-89-008, pp. 47, March 1989.

Winterford, D.
Sino-Soviet detente: New challenge to American interests in Asia
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-56-89-005, 1989.

DEPARTMENT OF OCEANOGRAPHY

CONFERENCE PRESENTATIONS

Batteen, M.L.
Mesoscale modeling of eastern boundary coastal regimes: A time and space challenge
Mesoscale Interactive Air-Sea Coupling Workshop, Monterey, CA, August 31 - September 1, 1989.

Batteen, M.L.
Numerical modeling study of Leeuwin current eddy field
Presented at the American Geophysical Union (AGU) Fall Meeting, San Francisco, CA, December 4-8, 1989.

Batteen, M.L.
Modeling studies of Eastern boundary coastal circulations
Presented to the Oceanography Society Inaugural Meeting, Monterey, CA, August 27-30, 1989.

Berryman, P., Rago, T., Collins, C.A.
Velocity measurements off Pt. Sur, California
Presented at the Oceanography Society Annual Meeting, Monterey, CA, 1989.

Bird, A.A., Smith, D.C.
Eddy jet interactions as revealed by animation geophysical union
Fall Meeting, American Geophysical Union, San Francisco, CA, December 1989.

Bourke, R.H.
The Jan Mayen current
Presented at the Greenland Sea Workshop, Monterey, CA, February 15-16, 1989.

Bourke, R.H.
Ambient noise in the Arctic ocean
Presented at the Seminar at Geophysical Institute, University of Bergen, Norway, September 27, 1989.

Bourke, R.H.
Arctic ambient noise as measured by drifting buoys
Arctic Technology Workshop, Hanover, NH, June 20-23, 1989.

Bourke, R.H., Addison, V.G., Paquette, R.G.
Deep and bottom water formation in Baffin Bay
Presented at the Inaugural Meeting of the Oceanography Society, Monterey, CA, August 28-30, 1989.

Chu, P.C., Tsai, C.M., P. Jessen, P.C. Chu, C.A. Collins
Small scale structure of California currents from combined XBT/ADCP measurements
Fall National Meeting, American Geophysical Union, San Francisco, CA, December 7, 1989.

Chiu, C.-S., Ehret, L.L.
Computations of sound propagation in a three-dimensionally varying ocean: A coupled mode approach
Presented at the 2nd IMACS Symposium on Computational Acoustics, Princeton University, Princeton, NJ, March 15-17, 1989.

Chiu, C.-S., Newhall, A.E.
Improvements in three-dimensional raytracing codes for underwater acoustics
Presented at the 2nd IMACS Symposium on Computational Acoustics, Princeton University, NJ, March 15-17, 1989.

Chu, P.C.
Air-ice-ocean feedback mechanism and glacial cycles
Symposium on Ice and Climate, International Glaciological Society, Seattle, WA, August 20-25, 1989.

Chu, P.C., Garwood, R.W.
Hydrological effects on the air-ocean coupled system
Presented at the International TOGA/COARE Conference, Noumea, New Caledonia, May 24-30, 1989.

Chu, P.C., Garwood, R.W.
Cloud-ocean mixed layer feedback
Presented at the American Meteorological Society Meeting, Anaheim, CA, January 30 - February 3, 1989.

Chu, P.C., Garwood, R.W.
Effects of vertical mixing and entrainment on the equatorial air-sea coupled system
Presented at the Oceanography Inaugural Meeting, Monterey, CA, August 27-30, 1989.

Chu, P.C., Garwood, R.W.
Importance of cloud-oceanic mixed layer feedback in ocean prediction
Presented at the Air Sea Conference, Monterey, CA, August 31 - September 1, 1989.

Chu, P.C., Garwood, R.W., Muller, P.
Unstable and damped modes in coupled cloud and ocean mixed layer system
Presented at the 21st International Liege Colloquim on Ocean Hydrodynamics, Liege, Belguim, May 8-12, 1989.

Collins, C.A., Berryman, P., Rago, T.
Velocity measurements off Pt. Sur California
Presented at the Oceanography Society Annual Meeting, Monterey, CA, August 1989.

Collins, C.A., Rago, T.A.
Vertical structure of currents on the axis of Monterey submarine canyon in water 2200m deep
Eastern Pacific Oceanic Conference, Asilomar, 1989.

Dodd, N., Oltman-Shay, J.
Shear waves in the nearshore: A comparison of theory and observation
Presented at the American Geophysical Union, San Francisco, CA, December 5-9, 1989.

Garwood, R.W., Chu, P.C., Muller, P.
Equatorial entrainment: The diurnal cycle
Presented at the International TOGA/COARE Conference, Noumea, New Caledonia, May 24-30, 1989.

Nystuen, J.A.
Monitoring oceanic precipitation using ambient sound - an assessment
Acoustical Society of America, Syracuse, NY, Spring 1989.

Ramp, S.R.
Comparison of CTD temperature and continuous in-situ florescence in the upper water column during CTZ mapping cruises on 3-4 of July, 1988
Presented at the CTZ PI Meeting, Corvallis, OR, July 1989.

Ramp, S.R., Garwood, R.W., Davis, C., Snow, R.L.
Surface heating and patchiness in the coastal ocean off central California during a wind relaxation event
Presented at the Inaugural Meeting of the Oceanography Society, Monterey, CA, August 1989.

Scott, K., Thornton, E.B.
Mean cross-shore and longshore currents on a barred beach
American Geophysical Union, San Francisco, CA, December 5-9, 1989.

Smith, D.C., Bird, A.A.
A numerical study of eddy interaction with an ocean jet spring meeting
Presented at the American Geophysical Union, Baltimore, MD., May 1989.

Smith, D.C., Bird, A.A.
A numerical study of circulation in Monterey Bay
Presented at the Oceanography Society, Monterey, CA, August 1989.

Smith, D.C., Bird, A.A.
Factors influencing asmmetry and self advection in ocean eddies
Synoptic Mesoscale Coherent Vortices in Geophysical Turbulence Elsevier, Nihoul ed., 1989.

Smith, D.C., Bird, A.A.
Dipole formation mechanisms in the marginal ice zones
Fall Meeting, American Geophysical Union, San Francisco, CA, December 1989.

Stanton, T.P.
Momentum fluxes in a wind driven surface gravity field
Presented at the AGU Fall Meeting, San Francisco, CA, December 1989.

Stanton, T.P.
Estimation of reynolds stresses using a bistatic coherent doppler profiler
TOS Inaugural Meeting, Monterey, CA, August 1989.

Thornton, E.B.
Status and future research direction of nearshore currents
Presented at the Conference on Research in Nearshore, St. Petersburg, FL, April 27-28, 1989.

Thornton, E.B., Dodd, N.
Mixing in the nearshore by shear waves
American Geophysical Union, San Francisco, CA, December 5-9, 1989.

Tsai, C.M. Jessen, P., Chu, P.C., Collins, C.A.
Circulation of the California undercurrent near Monterey
Presented at the Fall National Meeting, American, Geophysical Union, San Francisco, CA, December 1989.

Tsai, C.M., Jessen, P., Chu, P.C., Collins, C.A.
Transition between eddy-dominant and longshore current dominant regions in the California currents
Presented at the Amer. Geophys. Union Fall Meeting, San Francisco, CA, December 4-8, 1989.

Wu, C.S., Thornton, E.B.
Monochromatic and random wave modeling of rip currents on a barred beach
American Geophysical Union, San Francisco, CA, December 5-8, 1989.

PUBLISHED PAPERS

Batteen, M.L.
Review of the baroclinic circulation of the West Sptizbergen current
Springer-Verlag Coastal and Estuarine Studies on Poleward Flows Along Eastern Ocean Boundaries, pp. 66-67, 1989.

Batteen, M.L.
Model simulations of a coastal jet and undercurrent in the presence of eddies and jets in the California current system
Sringer-Verlag Coastal and Estuarine Studies on Poleward Flows Along Eastern Boundaries, pp. 263-279, 1989.

Batteen, M.L., Haney, R.L., Tielking, T.A., Renaud, P.G.
A numerical study of wind forcing of eddies and jets in the California current system
J. Mar. Res., 47, (3), pp. 493-23, 1989.

Batteen, M.L., Nelson, C.S., Edson, R.W., Lopes da Costa, C.N.
Modeling studies of Eastern boundary coastal circulations
Poster T3.ML.01, The Oceanography Society Inaugural Meeting, pp. 43-44, 1989.

Batteen, M.L., Rutherford, M.J.
A numerical modeling study of Leeuwin current eddy field
Paper Presented at the Trans. Am. Geophys. Union, 70, 1140, 1989.

Bourke, R.H., Addison, V.G., Paquette, R.G.
Oceanography of Nares Strait and Northern Baffin Bay in 1986 with emphasis on deep and bottom water formation
Journal of Geophys. Res, 94, (C6), pp. 8239-8302, 1989.

Bourke, R.H., Paquette, R.G.
Estimating the thickness of sea ice
Journal of Geophys. Res., 94, pp. 919-923, 1989.

Bourke, R.H., Weigel, A.M.
The baroclinic circulation of the West Aptisbergen current
Poleward Flows Along Eastern Ocean Boundaries, Springer Verlag, New York, pp. 47-65, 1989.

Chu, P.C.
Relationship between thermally forced surface wind and sea surface temperature gradient
Pure & Appl. Geophys., 130, pp. 31-34, 1989.

Chu, P.C., Garwood, R.W.
Cloud-ocean mixed layer feedback
Role of Clouds in Atmospheric Chemistry and Global Climate, Amer. Meteoro. Soc., pp. 39-44, 1989.

Chu, P.C., Garwood, R.W.
Effects of hydrological cycle on the Air-ocean coupled system
Trans. Amer. Geophys. Union, 70, 297, 1989

Chu, P.C., Garwood, R.W.
Effects of vertical mixing and entrainment on the equatorial air-sea coupled system
TOSIM, 11, 1989.

Istweire, E.C., Osborne, T.R., Stanton, T.P.
Horizontal distribution and characteristics of shear layers in the seasonal thermocline
J. Phys. Oceanogr., 19, pp. 301-320, 1989.

Medwin, H., Kurgan, A. Nystuen, J.A.
Impact and bubble sound from raindrops at normal and oblique incidence
Journal of Acoustic. Society of America, December 1989.

Nystuen, J.A., Farmer, D.M.
Precipitation in the Canadian Atlantic storms program: Measurements
of the acoustic signature
Atmosphere-Ocean 27, pp. 237-257, 1989.

Rago, T.A., Collins, C.A.
Measurements of ocean currents across the continental margin off Pt. Sur California, from April 1988 to March 1989
Trans. Am. Geophys. Union 70 (43), pp. 1156, 1989.

Robson, A., Collins, C.A., McCann, M.
Circulation of the California undercurrent near Monterey
Trans. Am. Geophys. Union 70, 430, pp. 1156, 1989.

Smith, D.C., Bird, A.A.
Factors influencing asymmetry and self advection in ocean eddies
Synoptic/Mesooscale Coherent Vortices in Geophysical Turbulence Elsevier, 1989.

Smith, D.C., Bird, A.A., Budgell, W.P.
A numerical study of mesoscale eddy interaction with a marginal ice zone
Journal of Geophysical Research, 93, pp. 12461-12473, 1989.

Smith, D.C., Davis, G.P.
Numercial study of eddy interaction with air ocean jet
Journal of Physical Oceanography, 19, pp. 975-986, 1989.

Stanton, T.P.
Momentum fluxes in a wind driven surface gravity wave field
Trans. Am. Geophys. Union, 70, 1166, 1989.

Stanton, T.P.
Estimation of reynolds stresses using a bistatic coherent doppler profiler
Poster T3, OA, 04, 42, 1989.

Tsai, C.M., Jessen, P. Chu, P.C., Collins, C.A.
Small-scale structure of California currents from combined XBT/ADCP measurements
Trans. Amer. Geophys. Union, 70, 1156, 1989.

TECHNICAL REPORTS AND NOTES

Edson, R.W., Batteen, M.L., Nelson, C.S.
The effects of climatological and transient wind forcing on eddy generation in the California current system
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-68-89-008, 1989.

Gunderson, C.R., Batteen, M.L., Nelson, C.S.
Saline impact on the California current system
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-68-89-006, 1989.

Jessen, P.F., Ramp, S.R., Clark, C.
Hydrographic data from the pilot study of the coastal transition zone (CTZ) program: March 17-26, 1987
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-68-89-001, 1989.

Jessen, P.F., Ramp, S.R., Clark, C.
Hydrographic data from coastal transition zone program: 15-28 June 1987
Prepared for the Naval Postgraduate School, NPS-68-89-004, 1989.

Lopes da Costa, C.N., Batteen, M.L., Nelson, C.S.
A numerical study of wind forcing in the eastern boundary current system off Portugal
Prepared for the Naval Postgraduate School, NPS-68-89-007, 1989.

DEPARTMENT OF OPERATIONS RESEARCH

CONFERENCE PRESENTATIONS

Bailey, M.P.
Constant access systems
Nicholson Prize Award Technical Session, CORS/TIMS/ORSA, Vancouver, B.C., Canada, May 1989.

Bradley, G.H.
Mathematical programming modeling project - overview
ORSA Conference on the Impact of Recent Computer Advances on Operations Research, Williamsburg, VA, January 3-8, 1989.

Bradley, G.H.
Optimization modeling environment - mathematical programming modeling project (MP2)
KMS Software User Group Meeting, Monterey, CA, September 18-19, 1989.

Bradley, G.H., Geoffrion, A.
Capital portfolio optimization in a telephone company
ORSA/TIMS Joint National Meeting, New York, October 16-18, 1989.

Bradley, G.H., Mayer, M.M.
Optimization modeling environment - mathematical programming modeling project
CORS/TIMS/ORSA Joint National Meeting, Vancouver, May 8-10, 1989.

Brown, G.G., Lawphongpanich, Podolak, K.A.
Port operations planning
CORS/TIMS/ORSA Joint National Meeting, Vancouver, May 8-10, 1989.

DeWolfe, D.D., Stevens, J.G., Wood, R.K.
Determination of military reenlistment bonuses
CORS/TIMS/ORSA Joint National Meeting, Vancouver, May 8-10, 1989.

Eagle, J.N.
Cumulative search-evasions games
57th MORS, June 1989.

Gaver, D.P.
Topics in finite-time inference for service systems
TIMS XXIX, Osaka, Japan, July 23-26, 1989.

Gaver, D.P., Morrison, J.A., Pilnick, S.
Multi-type repairman problems with queue-sensitive control
ORSA/TIMS Joint National Meeting, New York, NY, October 16-18, 1989.

Harrison, T.P., Bradley, G.H., Brown, G.G.
Capital allocation and project selection via decomposition
CORS/TIMS/ORSA Joint National Meeting, Vancouver, May 8-10, 1989.

Hearn, D.W., Lawphongpanich, S.
Generalized linear programming with line searchers
28th IEEE Conference on Decision and Control, Tampa, FL, December 13-15, 1989.

Hughes, W.P.
Battle physics: The fundamental nature of combat momentum
The Military Conflict Institute 12th Working Meeting, October 1989.

Lawphongpanich, S.
Two algorithms for linearly constrained convex program
ORSA/TIMS Meeting, New York, NY, October 16-18, 1989.

McMasters, A.
A new replenishment model for the wholesale level in the U.S. Navy
SOLE/NPS 7th Annual Logistics Symposium, Monterey, CA, May 13, 1989.

Milch, P.R., Johnson, J.L.
An interactive computer model to forecast Navy officer distribution
Joint National ORSA/TIMS Meeting, New York City, October 18, 1989.

Olsen, M.P., Brown, G.G., Wood, R.K., McBride, R.
Dynamic factorization approach for solving the multicommodity transshipment problem
CORS/TIMS/ORSA Joint National Meeting, Vancouver, May 8-10, 1989.

Parry, S.H.
The use of renewal models as a surrogate for combat simulations
58th Military Operations Research Symposium, Fort Leavenworth, KS, June 1989.

Punetenny, M.C., Rosenthal, R.E., Wood, R.K.
Network reduction with a logistics application
CORS/TIMS/ORSA Joint National Meeting, Vancouver, May 8-10, 1989.

Sternberg, C., Jones, R., Thackery, R.
The assessment of the importance of information in the execution of the maritime strategy
Proceedings at the 1989 Symposium on Command and Control Research, pp. 27-29, June 1989.

Thomas, G.
Distance to work behavior
American Statistical Association Conference on Social Statistics. Winter 1989.

Thomas, G.
Modeling reservists'
American Statistical Association Annual Meeting, 1989.

Washburn, A.R.
Cumulative search evasion games
New York ORSA/TIMS, October 17, 1989.

Whitaker, L.R.
Sequential estimation of an optimal age replacement policy
Annual Joint Meeting of the Institute of Mathematical Statistics and the American Statistical Association, Washington, DC, August 6-10, 1989.

PUBLISHED PAPERS

Barton, R.R., Hearn, D.W., Lawphongpanich, S.
On the equivalence of transfer and generalized benders decomposition
Transportation Research, 23B, no. 1, pp. 61-71, 1989.

Bradley, G.H.
Mathematical programming modeling project - overview
Impact of Recent Computer Advances on Operations Research, Ramesh Sharda et al, (eds), North-Holland, New York, pp. 447-462, 1989.

Gaver, D.P., Mutlu, H.B.
An operational analysis of system calibration
Naval Research Logistics 36, pp. 373-382, 1989.

Hearn, D.W., Lawphongpanich, S.
Lagrangian dual ascent by generalized linear programming
Operations Research Letters, vol. 8, pp. 89-196, 1989.

Johnson, L., Thomas, G.
Modeling reservists' commute behavior
Proceedings of 1989 Annual ASA Conference on Social Statistics, 1989.

Lewis, P.A.W., Ressler, R.L., Wood, R.K.
Variance reduction using nonlinear controls and transformations
Communications in Statistics, Simulation, and Computation, vol. 18, no. 2, 1989.

Schrady, D.A.
Measures of effectiveness in logistics
Underway Replenishment Journal, July 1989.

TECHNICAL REPORTS AND NOTES

Bailey, M.P.
Constant access systems: A general framework for greedy optimization on stochastic networks
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-55-89-02, 1989.

Bausch, D.O., Brown, G.G., Hundley, D.R., Rapp, S.H., Rosenthal, R.
Mobilizing Marine corps officers
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-55-89-009, 1989.

Eagle, J.N., Washburn, A.R.
Cumulative search evasion games (CSEGs)
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-55-89-005, March 1989.

Esary, J.D.
A comparison of an empirical rule for aggregating damage from a weapons salvo to a plausible model for the same purpose
Working Paper on Damage Aggregation, Naval Postgraduate School, April 1989.

Esary, J.D.
Damage agregation for a weapons salvo by an empirical rule related to the poisson approximation to the binomial
Working Paper on Damage Aggregation, Naval Postgraduate School, July 1989.

Forrest, R.N.
Notes on search detection and localization modeling
Prepared for the Naval Postgraduate School, NPS-71-87-001, Revised October 1989.

Forrest, R.N.
Three position estimation procedures
Prepared for the Naval Postgraduate School, NPS-55-84-013 Revised April 1989.

Forrest, R.N.
Search times and false targets
Prepared for the Naval Postgraduate School, NPS-71-89-001, July 1989.

Hughes, W.P.
Command and control within the framework of a theory of combat
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-55-89-05, May 1989.

Jacobs, P.A., Gaver, D.P.
Inferring finite-time performance in the M/G/1 queueing model
Prepared for the Office of Naval Research, Arlington, VA, NPS-55-89-01, January 1989.

Keith, I.H., Lewis, P.A.W.
Analyze.AWS A user's manual for categorical data analysis in APL (version 1.1)
Prepared for the Chief of Naval Research, Arlington, VA, NPS-55-89-008, June 1989.

Lawphongpanich, S., Rosenthal, R.E.
A multi-modal development planning problem
Interim Report, May 1989.

Lawphongpanich, S., Rosenthal, R.E.
Estimating the minimum number of assets to support a deployment
Final Report, October 1989.

Parry, S.H., Schoenstadt, A.L.
Future state decision making under the generalized value system architecture
Prepared for the Naval Postgraduate School, NPS-53-89-013, July 1989.

Schrady, D.A.
Measures of effectiveness in logistics
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-55-89-07, May 1989.

Shudde, R.H.
A satellite simulation program
Prepared for the Naval War College Wargaming Department, Newport, RI, September 1989.

Wagner, D.H.
Naval tactical decision aids
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-55-89-11, September 1989.

Washburn, A.R.
Finite methods for a nonlinear allocation probelm
Prepared for the Naval Postgraduate School, NPS-55-89-003, March 1989.

DEPARTMENT
OF
PHYSICS

CONFERENCE PRESENTATIONS

Anderson, R.R., Olsen, R.C., Mozer, F.S.
Plasma wave observations during electron gun operations on ISEE 1
Presented at the American Geophysical Union Meeting in San Francisco, CA. December 1989.

Atchley, A.A., Hofler, T.J., Ao, C.
The measurement of thermoacoustic phenomena using thermoacoustic couples
J. Acoust. Soc. Am. 86(1), S109(A), 1989.

Atchley, A.A., Hofler, T.J., Chia-ning, A.
The measurement of thermoacoustic phenomena using thermoacoustic couples
J. Acous. Soc. Am. 86, Suppl. 1, 1989.

Atchley, A.A., Hofler, T.J., Garrett, S.L.
Simple demonstration of a thermoacoustic sound source
J. Acoust. Soc. Am. 85, Suppl. 1, 1989.

Atchley, A.A., Perron, R.A., Lineberger, E.R.
Measurement of bubble properties using a multi-frequency sound field
J. Acoust. Soc. Am. 85, Suppl. 1, S5(A), 1989.

Cleary, D.D.
Measurements of the photoabsorption cross section of molecular nitrogen near the OII 834 A emission
Presented at the American Geophysical Union Spring Meeting, Baltimore, MD, May 6, 1989.

Cleary, D.D.
The effects of N2 absorption of the O+ 834 A emission in the earth's ionosphere
Presented at the National Institute of Standards and Technology, Gaithersburg, MD, March 29, 1989.

Garrett, S.L., Hofler, T.J., Fitzpatrick, M., Suzalla, M.P., Volkert, R., Harris, D.
Thermoacoustic refrigerator for space applications
J. Acoust. Soc. Am. 85(1), S48, 1989.

Hofler, T.J., Atchley, A.A., Garrett, S.L.
Simple demonstration of a thermoacoustic sound souce
J. Acoust. Soc. Am. 85(1), S112, 1989.

Larraza, A., Garret, S.L., Putterman, S.
Dispersion relations for gravity waves in a deep fluid: Second sound in a stormy sea
Bull. Am. Phys. Soc. 34(10), 2276, 1989.

Mirick, R.A., Baker, S.R., Oscar, B.
Apparatus to determine the complex mass density of a viscous fluid contained in a rigid porous solid from acoustic pressure measurements
J. Acoust. Soc. Am. 86 S1, S119, 1989.

Neighbours, J.R., Buskirk, F.R., Maruyama, X.K., Snyder, D., Lally, R. Nye, H.
Wide band R.F. measurements of the signals from an electron beam
DARPA/SDIO/ Services Annual Charges Particle Beam Review, Monterey, CA, September 18-21, 1989.

Nielsen, S.T., Mikkelsen, T., Larsen, S.E., Troen, I., deBass, A.F., Kamada, R.F., Skupniewicz, C.E., Schacher, G.E.
Model for accidental releases in complex terrain
Proceedings of the 17th NATO/CCMS ITM, Cambridge (UK), Plenum, New York, 1989.

Olsen, R.C.
A hollow cathode rocket experiment
Presented at the AIAA 27th Aerospace Sciences Meeting, Reno, NV, January 9-12, 1989.

Olsen, R.C.
Current limiting mechanisms in electron and ion beam experiments
Presented at the 1st Workshop on Current Collection from Space Plasmas, Huntsville, AL, April 24-25, 1989.

Olsen, R.C.
Interactions between spacecraft, ion propulsion systems, and the environment
Presented at the INTELSAT Symposium on Ion Propulsion for Communications Satellites, Monterey, CA, July 13, 1989.

Olsen, R.C., Patterson, J.W., Aggson, T.L., Ledley, B.G.
Observations of resonance phenomenon in a micropulsation
Presented at the American Geophysical Union Meeting in Baltimore, MD, May 1989.

Olsen, R.C., Patterson, J.W., Aggson, T.L., Ledley, B.G.
Multipoint observations of a micropulsation
Presented at the 6th Scientific Assembly of IUGG/IAGA, Exeter, United Kingdom, August 3, 1989.

Olsen, R.C., Thompson, G.C.
VLF Space transmitter
Presented at the 3rd International Conference on Tethers in Space - Towards Flight, San Francisco, CA, May 17-19, 1989.

Perron, R.A., Atchley, A.A.
Measurement of bubble properties using a multi-frequency sound field
Meeting of the Canadian Acoustical Society, Halifax, Novia Scotia, Canada, October 1989.

Schwirzke, F
Formation of cathode spots by unipolar arcing
Presented at the 42nd Annual Gaseous Electronics Conference, Palo Alto, CA, October 17-20, 1989.

Schwirzke, F.
Laser induced breakdown and high voltage induced breakdown on metal surfaces
Presented at the 9th International Workshop on Laser Interaction and Related Plasma Phenomena, Monterey, CA, November 6-10, 1989.

Schwirzke, F., Maruyama, X.K., Minneck, S.A.
Onset of breakdown in a vacuum diode
Presented at the 31st Annual Meeting of the Division of Plasma Physics, Anaheim, CA, November 13-17, 1989.

Schwirzke, F., Maruyama, X.K., Minnick, S.A.
Onset of breakdown in a vacumm diode
Bull. Am. Phys. Soc. 34, 2103, 31st Annual Meeting of the Division of Plasma Physics of the American Physical Society, Los Angeles, CA, October 1989.

Walters, L.
Optimal site selection
U.S. Naval Observatory, February 4, 1989.

PUBLISHED PAPERS

Atchley, A.A.
The blake threshold of a cavitation nucleus having a radius-dependent surface tension
J. Acoust. Soc. Am. 85, pp. 152-157, 1989.

Atchley, A.A., Prosperetti, A.
The crevice model of bubble nucleation
J. Acoust. Soc. Am. 86, pp. 1065-1084, 1989.

Brown, B.A., Garrett, S.L.
High sensitivity fiber-optic flexural disk hydrophone with reduced acceleration response
Fiber and Integrated Optics 7 (3), 1989.

Cleary, D.D., Barth, C.A., Siskind, D.E.
The effects of soft solar x-rays on the production of nitric oxide in the thermosphere
J. Geophys. Res., 1989.

Cleary, D.D., Meier, R.R., Gentieu, E.P., Feldman, P.D., Christensen, A.B.
Analysis of rocket observations of the OII 834 A emission near solar maximum
J. Geophys. Res., 1989.

Danielson, D.A., Garrett, S.L.
Fiber optic ellipsoidal flextensional hydrophones
J. Lightwave Tech., LT-7(12), pp. 1995-2002, 1989.

Denardo, B., Larraza, A.
A geometrical approach to sums of uniform random variables
Am. J. of Phys. 57, pp. 749, 1989.

Geesaman, D.F., Gilman, R., Green, M.C., Holt, R.J., Schiffer, J.P., Zeidman, B., Garino, G., X.K. Maruyama
Proton propagation in nuclei studied in the A dependence of the (e,e'p) reaction in the quasifree region
Physical Review Letters 63, pp. 734, 1989.

Larraza, A. Walker, M.B.
Surface phason modes in incommensurate crystals
Phys. Rev. B 40, pp. 977, 1989.

Larraza, A., Walker, M.B.
Amplitude-mode polaritions in the incommensurate phase of quartz
Phys. Rev. B39, pp. 2506, 1989.

Luna, H.B., Maruyama, X.K., Colella, N.J., Hobbs, J.S., Hornady, R.S., Kulke, B., Palomar, J.V.
Bremsstrahlung radiation effects in rare earth permanent magnets
Nuclear Instruments and Methods, A458, 1989.

Morrison, R., Cleary, D.D.
Measuremens of the photoabsorption cross section of molecular nitrogen near the OII 834 A emission
Geophys. Res., 1989.

Olsen, R.C., Lowery, D.R., Roeder, J.L.
Plasma wave observations during electron beam experiments at high altitudes
Journal of Geophysical Research, 94, pp. 17267-17273, 1989.

Piestrup, M.A., Boyers, D.G., Pincus, C., Qiang Li, Moran, Caplan, H.S, Silzer, Maruyama, X.K.Buskirk, F.R., Neighbours
Detection of coherent x-ray transition radiation and it's applications to beam diagnostics
Nuclear Instruments and Methods, B0/41, pp. 965, 1989.

Schwirzke, F.
Magnetic field generation in shock waves caused by plasma streamers
Bull. Am. Phys. Soc., 34, pp. 1276, Apr" 1989.

Schwirzke, F.
Formation of cathode spots by unipolar arching
Proceedings of the 42nd Annual Gaseous Electronics Conference, Palo Alt, CA, pp. 133, October 17-20, 1989.

Schwirzke, F., Maruyama, X.K., Minneck, S.A.
Onset of breakdown in a vacuum diode
Bull. Am. Phys. Soc., 34, pp. 2103, October 1989.

Skupniewicz, C.E., Kamada, R.F., Schacher, G.E.
Turbulence measurements over complex terrain
Bound. Layer Meteorol., 48, 109-128, 1989.

TECHNICAL REPORTS AND NOTES

Atchley, A.A.
Annual summary of basic research in thermoacoustic heat transports
Prepared for the Office of Naval Research, Physics Division, Arlington, VA, NPS-61-89-015PR, September 1989.

Critenden, E.C., Cooper, A.W.
Modification, testing, and calibration of infrared searching and target designator hardware received from NSWC
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-61-89-011, May 1989.

Crittenden, E.C., Rodenback, G.W., Cooper, A.W., Bourne, C.M.
Laser altimeter for use over the ocean
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-61-89-001, April 1989.

Harmonic, B., Wilson, O.B.
Introductory manual for the finite-element code atila
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-61-89-006, 1989.

Harmonic, B., Wilson, O.B.
Proceedings of mini-workshop on applications of the finite element code atila held at the Naval Postgraduate School
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-89-005, December 1989.

Kamada, R.F.
A prelinimary review of flow models considered for use at Vandenberg Air Force Base
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-61-89-007, 1989.

Kamada, R.F., Skupniewicz, C.E., Glendening, J.W., Schacher, G.E., Larsen, S., Mikkelsen, T., Thykier-Nielsen
Vandenberg meteorology and plume dispersion handbook for boundary layer releases
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-61-89-004, 1989.

Neighbours, J.R., Buskirk, F.R., Maruyama, X.K.
Frequency content of coherent Cherenkov radiation
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-61-90-001, November 1989.

Olsen, R.C.
Current limiting mechanisms in electron and ion beam experiments
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-61-89-013, 1989.

Olsen, R.C.
Charging characteristics of dynamics explorer I retarding ion mass spectrometer and the consequence for core plasma measurements
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-61-89-014, September 1989.

Wilson, O.B., Esary, J.D.
Annual summary report range studies program
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-61-89-008, 1989.

Woehler, K.E.
Professor John Dyer memorial lecture: The origin of the universe from quantum chaso: An introduction to current ideas
Prepared for the Naval Postgraduate School, Monterey, CA, NPS-61-89-010, May 1989.